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THE OX:

Its External and Internal Organisation.

An Illustrated Representation and Brief Description.

BY

A. SEYFFERTH,

MUNICIPAL VETERINARY SURGEON TO THE DISTRICT OF FÜRTH.

REVISED AND EDITED BY

PROFESSOR G. T. BROWNE, C.B.

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ITS EXTERNAL AND INTERNAL STRUCTURES.

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[190-?]

PREFACE.

VERY few words will be necessary to explain the object and uses of this handbook on the Ox, one of a series introduced to the English reader by the same publishers. The chief feature of the books is the coloured models, which are ingeniously arranged to exhibit a fairly accurate view of exterior form and internal structure. Absolute accuracy of detail would necessitate drawing on a much larger scale than that adopted in the series of handbooks, and would, besides, be extremely costly; but it may be claimed for the models that they show all that could possibly be compressed into a small space.

In preparing this little work for the press the Editor has taken some liberties with the original text. The description of organs has been made as concise as possible, and all cursory references to disease have been omitted, as being outside the scope of the work. Advantage has been taken of the opportunity to introduce, by the kind permission of the Royal Agricultural Society, a number of woodcuts illustrating the teeth of the Ox from birth to advanced age, and in its present form the handbook on the Ox will be instructive to the Owner of Stock, who may find a new interest in learning something of the anatomy of the animals which are constantly under his observation; while the Student, and possibly the experienced Veterinarian, may amuse a leisure hour in refreshing his memory of structures—a knowledge of which was formerly gained by arduous work in the dissecting room.

G. T. B.

THE OX.

THE OX (*Bos Taurus Domesticus*) is one of the herbivorous mammalians, of the order of Ruminants, which includes animals which chew the cud and are cloven-footed. The feet, as in the case of the horse, are protected by a covering of horn, constituting the hoof, which, instead of being single, is divided in the centre. The cleft in the bones extends to the fetlock joint, at the back of which there are in the ox two small knobs of horn, which are known as dew claws.

A good deal of obscurity is associated with the origin of the domestic ox, and the following account must be accepted as traditional.

The origin of our domestic cattle can be traced principally back to three different races of wild species. The opinions of our investigators on this subject vary very greatly, so that there can be no settlement of the question for a long time to come. Among the ancestry of the forty to fifty distinct breeds of domestic cattle now living in Europe, must be mentioned—first, the Primeval Ox (*Bos primigenius*), which must probably be considered as identical with the Ure Ox; secondly, the Long-forehead Ox (*Bos longifrons*); and thirdly, the Broad-forehead Ox (*Bos frontosus*), relics of which have been found and dug up in pile-dwellings and bogs in various parts of Europe. It has been thought possible that this last-named might be the ancestor of the Norwegian Mountain Ox; the Long-forehead Ox is regarded as the forefather of the ox which during the stone age was kept as a domestic animal in Switzerland, and in later years was brought to England by the Romans; while the Primeval or Ure Ox is thought to be the parent of the stronger races of the mainland. That this latter has the greatest claim to be considered as the ancestor of the majority of our races of cattle may be shown by comparing its skull with that of the domestic ox. From cross-breeding of the above-named, and possibly also of other primitive races, originated the ox of historical times. The races of our time still show evidences, in the structure of the skeleton and skull, of their relationship with the above-named species; but mode of life, place of dwelling, occupation, feeding, and breeding, acted in the course of centuries on the external shape, and a classification of the breeds in regard to their ancestors can only be arranged within limited bounds.

The modern classification of the races is derived from various aspects. While formerly there were three principal groups—(*a*) mountain breeds, (*b*) lowland breeds, (*c*) middle or highland breeds—which displayed various bodily shapes, according to their mode of life, dwelling, and work; others have decided the classification by colour. In this manner are distinguished—(*a*) the grey races of Eastern Europe, (*b*) the parti-coloured ox of Central and Western Europe, and (*c*) the black, brown, yellow, to white non-spotted races of Central Europe. Now-a-days, in some parts of the world, solitary breeds,

tribes, and families are named after geographical or political divisions; often enough they are called after quite small breeding places, after districts, valleys, ranges—even after hamlets.

The specification of each separate race, breed, and family would be too discursive. Still it may be noted that a classification of the different species, tribes, and breeds, according to their salient peculiarities, referring to milk-producing, to the meat and fat production, and capacity for work, will be touched upon. For the fairly large and small breeder, this standard is less applicable; he must strive to unite all these capacities as much as possible. In Europe, half-wild cattle are still found in parks in England and Scotland, as well as in Spain. In Lithuania, in the primeval forests of Bralowitch, the still savage Ure ox is occasionally met with, the size of which has decreased considerably in the course of centuries. It is still, however, the largest mammal of the European continent; in a general way, it is only found in the Caucasus.

Outside the European cattle, mention may be made of—the Indian ox (*Bos Indicus*), also the African ox (*Bos Africanus*). These are almost the only species of domestic cattle in Asia and Africa. The animals have fleshy humps, which distinguish them from our cattle, but these humps are disappearing through crossing with ours. They exhibit more intelligence and docility than our ox, and combine greater draught and carrying power, with rapidity of movement. The Hottentots use them in times both of peace and war for riding. They are grey or white in colour. Besides these, the Yak or grunting ox (*Bos Gruniens*), which, tamed in Northern China and Mongolia, is kept as a useful domestic animal, but is also met with in a savage state in herds, numbering as much as a thousand head of cattle. The Gyall or sylhetanish ox (*Bos Frontalis*) is found wild in the East Indies; it can be tamed, and in size and form resembles our domestic ox, and on that account different experts have classed it as of the same parentage. The Bison (*Bos Americanus*) is to North American oxen what the Ure ox (*Aurochs*) is in Europe. Before the age of man, millions of these animals inhabited the American continent, but have now almost entirely disappeared. The greed of men has annihilated them. The Gaur (*Bos Gaurus*) is much like the Gyall, is met with wild in India, and is also called the Indian Bison. The Bantang (*Bos Bantang*) of the Malays is an ox living in its wild state in Java, Borneo, and Sumatra, as well as on the mainland of the Malay Peninsula. The Arni (*Bos Arni*), an animal with rugged skin and a few black hairs, has no dewlap, or hardly any; it came originally from India, but is now distributed in Asia, Africa (Egypt), Turkey, Italy, and Hungary as a domestic animal. It is also still found in a savage state in India. The African Buffalo, the Kaffir Buffalo (*Bos Caffer*), and the Red Ox (*Bos Pumillus*), live in large herds, quite wild, the first named in the eastern half of Africa and in some parts of Cape Colony, the latter more in Western Africa. The Musk ox (*Bos Moschatus*), which is found all over the waste lands or deserts of the North American continent, and in parts of Greenland.

In the British Isles certain breeds are now and have for a long time been recognised. For example, Short-horns, Herefords, Devons, Sussex, Norfolk (polled), Long-horns, Welsh, Aberdeen, Angus (polled), West Highland, Galloway, Ayrshire, Jersey and Guernsey, and among Irish breeds, Kerry and Dexters.

Colour varies extensively in the different breeds: black, white, red, brown, fawn, roan, and combinations of white with other colours.

DENTITION AND JUDGING THE AGE OF CATTLE BY THEIR TEETH.

The adult ox has eight incisors, chisel-shape, in the front of the lower jaw, none in the upper jaw, which is provided with a dense fibrous pad. Molars, or grinding teeth, are present in both jaws—six on each side, top and bottom.

At birth the calf has usually the full complement of temporary incisors, milk teeth distinctly visible under the gum, with the edges of some of them pricking through, as seen in Fig. 1.

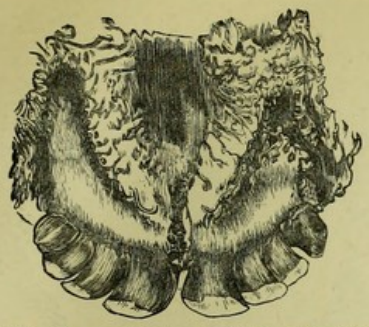

Fig. 1.—INCISORS OF CALF AT BIRTH.

For convenience of description the eight incisors are divided into four pairs, which are called, according to their position in the mouth, central, middle, lateral, and corner.

At a month old the eight milk teeth are well up, as shewn in Fig. 2.

Fig. 2.—INCISORS OF CALF AT ONE MONTH OLD.

Between one month and a year old the temporary incisors are affected by wear, and the jaw increases—the teeth are less crowded. In the next drawing, Fig. 3, the usual condition of the teeth at one year is shewn.

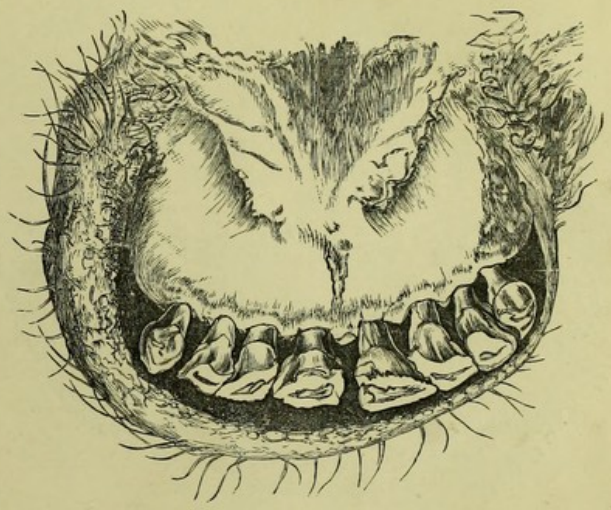

Fig. 3.—INCISORS AT ONE YEAR.

As age advances, the milk teeth in pairs, beginning with the centrals, give place to permanent or broad teeth; but it is necessary to observe that the changes are by no means so regular as in the horse. Sometimes twenty months may be expected to elapse before the first pair of broad teeth are cut. The next illustration, Fig. 4, shows the central broad teeth well up at twenty-two months.

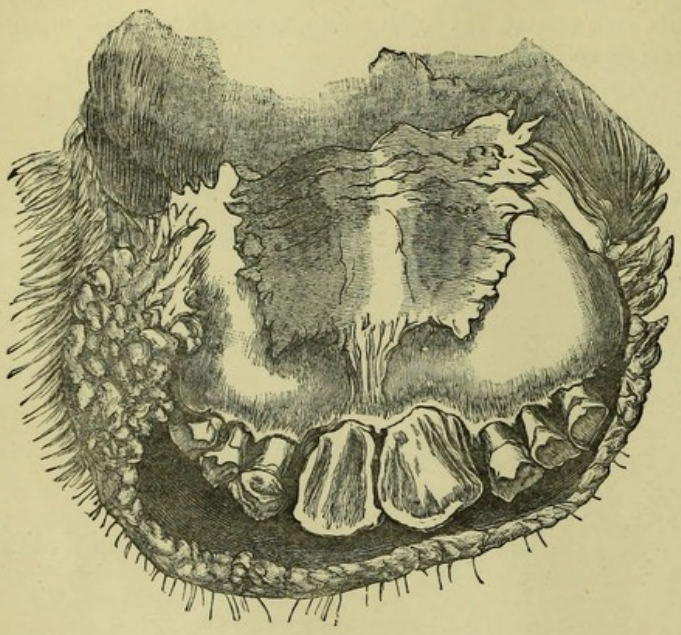

Fig. 4.—INCISORS OF OX AT ONE YEAR AND TEN MONTHS.

At two years and three months, to two years and six months, the second pair of broad teeth (middle) may be expected to appear, as shewn in Fig. 5.

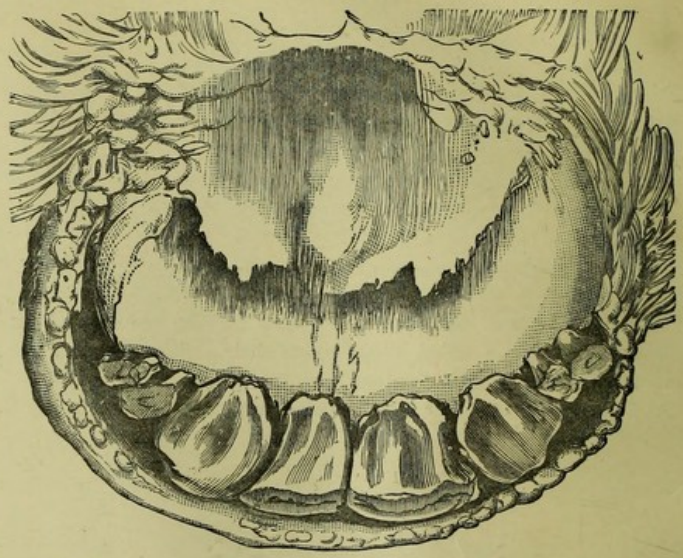

Fig. 5.—INCISORS OF OX AT TWO YEARS AND THREE MONTHS TO TWO YEARS AND SIX MONTHS.

The third pair of broad teeth (laterals) are still less regular, and may appear at any time between two years and six months and three years old, as shewn in Fig. 6.

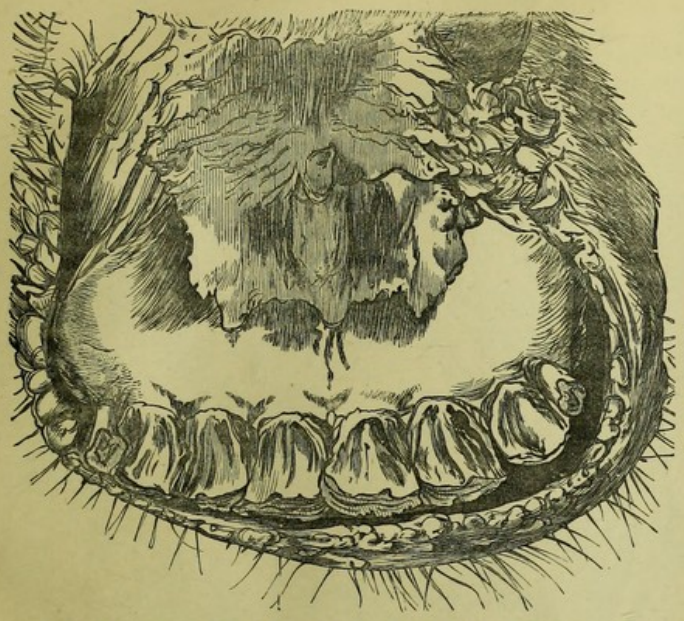

Fig. 6.—INCISORS OF OX AT TWO YEARS AND SIX MONTHS TO THREE YEARS OLD.

Of the fourth pair of incisors—the corner teeth—it may be remarked that they are sometimes cut soon after two years and six months, coming up, in fact, with the third pair. Only an experienced examiner can estimate the signs of age between two and three years with any approach to accuracy, and a careful examination of the molar teeth is necessary to enable him to form a correct opinion. The next figure illustrates the condition of the incisors from two years and ten months to three years and three months.

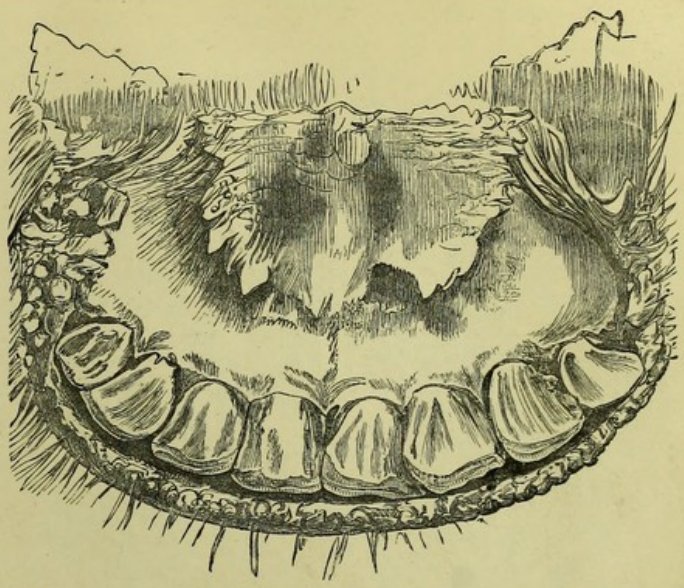

Fig. 7.—INCISORS OF OX FROM TWO YEARS AND TEN MONTHS TO THREE YEARS AND THREE MONTHS.

After the completion of the full set of permanent incisors, there remains only the accidental and irregular wear of the cutting edges of the teeth to guide the observer to an opinion as to the age of the animal, and it is hardly necessary to affirm that such evidence is not entirely reliable, and at the best is difficult to interpret. The next illustration is that of a six year old mouth.

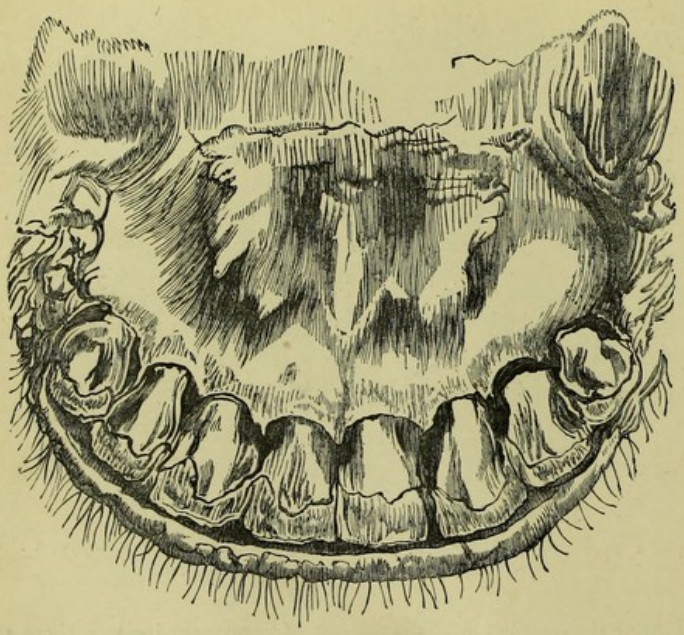

Fig. 8.—TEETH OF OX AT SIX YEARS.

A further illustration is given to indicate the change of form in the incisors at the advanced age of ten years.

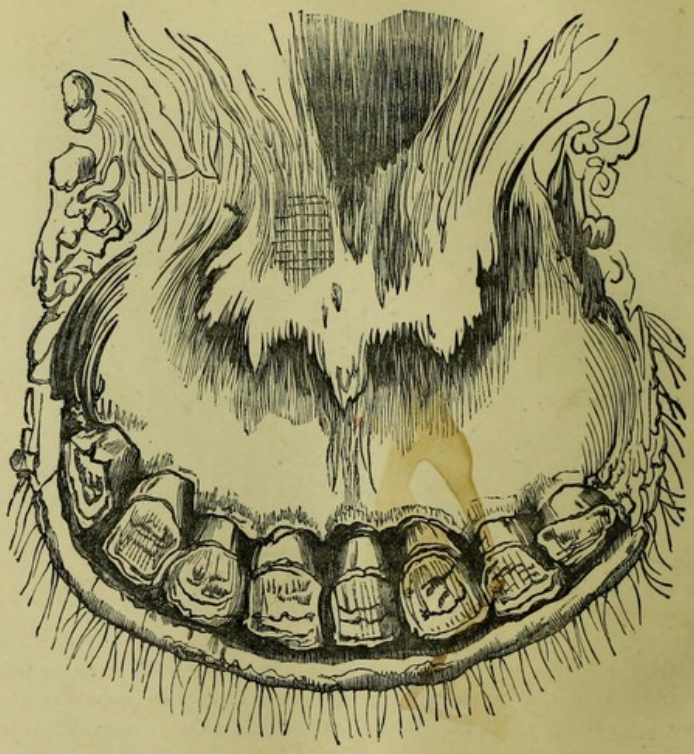

Fig. 9.—INCISORS OF OX AT TEN YEARS, SHEWING THE UPPER SURFACES OF THE TEETH WORN FLAT.

CONFORMATION.

Domestication has led to great changes in the conformation of the animals which are destined for food, generation has succeeded generation, and, under the influence of artificial selection, the natural type has been developed into a form best adapted to accommodate fat and flesh.

In the ox the perfect outline is that of the parallelogram, with small limbs, sufficient to support the weight.

The various parts of the body are separated by imaginary lines drawn by the butcher to indicate the joints of meat into which the animal, whatever may be its role in life, is intended to be divided at last. These divisions are shewn in the woodcut below.

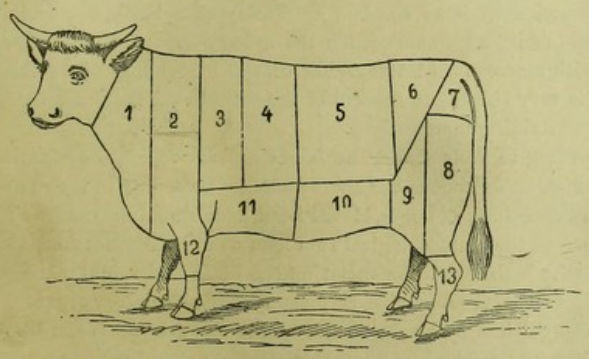

Fig. 10.—SHEWING DIVISIONS OF THE BODY OF THE OX.

1. Clod and Sticking.
2. Chuck and Leg of Mutton piece.
3. Middle Rib.
4. Fore Rib.
5. Loin.
6. Rump.
7. Aitchbone.
8. Buttock.
9. Thick Flank.
10. Thin Flank.
11. Brisket.
12. Shin.
13. Leg.

In the cow the characters or points which indicate high milking qualities are naturally most esteemed, and in their favour some of the peculiarities of form which are most sought for in breeding for the butcher have to be sacrificed. A combination of the two qualities in a high degree would constitute the ideal animal, and in some of the most advanced breeds an approach to the ideal standard has been achieved. Perfect success has not yet been attained, and it may be considered certain that breeds of cattle will continue to be cultivated specially for the dairy.

THE SKIN, ITS USES AND APPENDAGES.

Passing from the general survey to the particular study of the exterior of the body, the skin has first to be noticed.

A fine soft, mellow, elastic, and movable skin, is a point of excellence always recognised by judges of stock, rightly so, considering the importance of the structure as a protective covering to the whole of the body ; and further, as an extensive absorbing, secreting, and excreting organ. The appendages—the hair, and its modifications, nail, horn, and hoof—also have important and obvious parts to play in protecting sensitive structures and regulating temperature. In short, the skin may be said to have vitally essential work to do in covering, binding, and protecting the component parts of the body, helping to get rid of useless and effete materials, and assisting in the maintenance and regulation of animal heat, representing on the exterior of the body the more delicate mucus membrane which extends from it to line all the canals and cavities, which have communication with the exterior by means of appropriate openings.

MUSCULAR SYSTEM.

After removing the skin, the muscles are seen—red in colour, and at once recognised as the meat or flesh of the animal. Muscles are composed of an immense number of single so-called primitive muscular fibres, each of a pale red tint, but together forming a deep red mass. They are directly or indirectly attached by fibrous cords (tendons) to the bones, and by their contraction and expansion cause the movements

and changes of position according to the influence of the will, communicated by means of the nerves to each muscular filament, and the contraction occurs. Muscles are named generally according to the spot where they are fastened to the bones which they join, and particularly, also, according to their function. There are two kinds of muscle fibres —smooth and transversely striped. While the first-named are not dependent on the will of the animal, and are situated chiefly in the intestines, organs of sense, and in the blood-vessels and lymphatic glands, the oblique-striped muscular fibres of the collective muscles are, with few exceptions—the heart for instance—subservient to the will. These latter are so numerous in the so-called flesh of the animal body that they go to make up almost half its weight. According to their activity and position, the so-called voluntary muscles of the animal body assume the most varied shapes.

In addition to the movements of separate portions of the body (partial movements), the movement of the whole body from place to place, the animal's walk, is dependent on the contraction of the muscular system. The different paces are distinguished as the walk, which in the ox resembles the so-called amble, that is to say, the two limbs of the one side leave and touch the ground almost at the same instant; then the trot, which the ox only employs in flight or when driven; the gallop—the animal breaks into this generally only in the fields, or in places of exercise and in moments of joyful excitement. Sitting down and jumping are rare, and swimming is performed by a series of movements resembling a trot.

Between the skin and the muscles, as well as between single muscles and the muscular groups, fat is found in large quantities in every breed of oxen, and especially in fattened cattle. This fatty mass consists of lobes and clusters, and microscopically small cells, sharply divided one from another, and yet lying close together, of a more or less flattened, round, or oval shape. This fatty tissue represents primarily a reserve of food material. As an example of this, fat animals offer, in direct proportion to the quantity, a longer resistance to starvation than thin ones. Besides this, the round shape of the body is dependent on it for the filling-out material; it also protects the body from external mechanical influences, and, being a bad conductor of heat, it prevents a too rapid giving off of heat from the body.

On Plate IV. are represented those muscles which become visible when the skin is removed.

THE BONES OF THE SKELETON.

The skeleton includes all the bones of the body joined together, forms the framework of the animal, and determines its shape. Some of the bones enclose important and vital organs, while others form movable columns on which the muscles act as the mobile force. Thus bones contribute indirectly to motion. With the exception of a few head bones, each bone consists externally of a hard, compact, bony material (shell), which surrounds the spongy or cancellated structure filled with marrow. In the middle of the long bones the solid bone (shell) is very thick, and instead of the cancellated structure there is a cavity containing marrow.

According to their shape, the bones are divided into cylindrical or long bones, or flat bones and short bones. According to their position, they are described as bones of the head, trunk, and extremities; with reference to their physiological function, as neural bones and visceral bones, that is to say, those enclosing the brain and spinal marrow, and those protecting the digestive, respiratory, and circulatory organ. Bones are distinguished by hardness and slight elasticity. When bleached, bones appear almost white; but through the natural mingling of blood, fat, and juices, they present a yellowish pink colour in the fresh state. Their chief components are bone-earth and like organic substances. The essential mineral constituent is basal phosphoric acid, calcareous earth, besides which they contain carbonic acid lime, traces of fluoride of calcium, and phosphate of magnesia. The organic constituents are principally gelatine. During life the bones are covered by the so-called periosteum.

The ends of the bones are arranged to form joints of various kinds. They possess, also, processes, grooves, hollows, furrows, and roughened portions, which serve chiefly for attachment of the muscles, or their sinewy prolongations.

The bones are either fixed firmly and immovably one to the other by sutures, or—in the fore-limbs and trunk—they are joined together by fibrous cartilages *(vertebrate union)*, or by joints. The joints are held together by capsular and other kinds of ligaments, singly or in groups, according as they are formed by two or more bones in contact. They are known according to their use and movements as fixed joints, rotatory joints, gliding joints, and hinge joints. Besides this, the joints are surrounded by the so-called capsular ligaments, and have a special membrane which secretes the synovial fluid *(synovia)*. The ends of the bones, as they contribute to the formation of the joints, are covered with cartilage, an elastic, pliable, white, or bluish structure, which serves to lessen the shock of concussion.

The skeleton is divided into head, trunk, and limb bones. If we begin with the head, its bones are divided into skull-bones and face-bones. The first-named envelop the cavity of the skull or brain, and are bound together by numerous sutures, and enclose and protect the brain. They are divided into (*a*) the frontal bones, the largest bones of the skull, which form its front surface, and on the outer and upper corners of which are found the horn processes or horny lumps, with their wide foundation and sharp and round after-growth. Their shape, that is to say, their projection from the frontal bone and the consequent position of the bolster-like row of bony knobs surrounding the base of the horn-roots, furnish important indications as to race. (*b*) The parietal bones, (*c*) the occipital bone, (*d*) the sphenoid bone; (*e*) the temporal bones, which latter, with the lower jaw, form the jaw-bone or maxillary, and contain in their so-called stony part the organs of hearing; and lastly (*f*), the ethmoid bone, which shuts off the cavity of the skull on the lower side.

The face-bones form the foundation of the nasal, mouth, and throat cavities, and are joined to each other and to the skull bones by sutures, with the exception of the hyoid bone, which is attached to the skull by a half-joint (suture) and the vomer.

They are divided into—(*a*) The upper jaw-bones, which enclose on each side of the head the large cavity of the upper jaw, containing the molars, six on either side. (*b*) The anterior jaw-bones, which lie between the lower part of the upper jaw-bones, and help to form the cavities of nose and mouth. The front portion of the nasal cavity is closed by (*c*) the nasal bones. (*d*) The zygomatic bones lie above the upper jaws, between the frontal, lachrymal, and temporal bones, and form, in conjunction with these, the lower part of the orbital cavity and a portion of its upper edge. (*e*) The lachrymal bones, lying between the zygomatic, frontal, nasal, and upper jaw-bones. (*f*) The palate bones, which form the lower walls of the back part of the nasal cavity, and enclose between them the openings which lead from the nasal cavity to the cavity of the mouth. (*g*) On the inner side of the palate bones lie the pteryzoid bones, two small thin bones, attached to the former as well as to the sphenoid bone and vomer. (*h*) The vomer, a long thin bone, resembling a director, which is placed in the central line of the head, on the lower side of the palatal suture; and (*i*) The ethmoid plates, fine scales of bone, which come down from both sides of the ethmoid bone into the nasal cavity. (*j*) The lower jaw consists of two halves (branches), which are joined in the middle by a layer of cartilage, which is not entirely ossified except in old animals. In the anterior portion of the bones are eight cavities, which receive the roots of the eight incisors. On both sides of the jaw are the cavities for the reception of the roots of the twelve molars or grinding teeth. (*k*) The hyoid bone lies between the two branches of the lower jaw, supports the tongue, the larynx, and the œsophagus, and is the point of attachment for many of the muscles.

As already stated, both upper and lower jaw-bones contain the alveoli, or tooth sockets. According to their function, the teeth are classified as incisors and grinders, or molars: there are eight of the former in the

lower jaw, and six of the latter in both branches of the lower jaw and in each of the upper jaws.

The Vertebral Bones.—The bones of the trunk are divided into bones of the vertebral column, bones of the chest, and bones of the pelvis.

The bones of the spinal column are again divided into cervical (neck), dorsal (back), lumbar (loins), sacral (croup), and coccygeal (tail) bones. They form a row of closely connected bones, lying one behind the other, of which as many as are not grown together are named true vertebræ, and those which are united (as in the sacrum) are known as false vertebræ. Each true vertebra consists of the so-called body, and the arch, and has seven processes. The arches bend over the body, so forming the spinal marrow canal, which contains the spinal marrow within its membranes. Through the inter-vertebrate openings and foramina, lying in pairs, come through the vessels and nerves. From the middle of the upper surface of the arch springs the superior spinal processes, which vary in length in the different vertebræ: on both sides of the arch are the oblique processes. The front condyloid process is connected by joints with the back ones of the previous vertebræ.

The ox has (*a*) seven cervical vertebræ, of which the two near the head vary slightly in shape from the others. The first vertebra is called the atlas, the second the dentata. The third, fourth, and fifth vertebræ are of the same size. The spinal processes increase in size towards the back.

(*b*) The ox possesses thirteen dorsal vertebræ; they have long, strong, broad spinal processes, most of them sloping backwards. The oblique processes are smaller than in the cervical vertebræ, and each has on its under side the articular facet for uniting with the ribs. They are also articulated with each other. The first to the fifth dorsal vertebræ form the so-called withers.

(*c*) There are six lumbar vertebræ; they are distinguished by long oblique processes, taking a horizontal direction.

(*d*) The sacrum consists originally of five vertebræ, which, however, soon join together, and in full-grown animals form one bone lying between the bones of the pelvis. The spinal marrow canal becomes in this bone increasingly narrow towards the back, and encloses the end of the spinal marrow.

(*e*) There are eighteen to twenty tail vertebræ, of which the construction of the first four resembles that of the other vertebræ, as they contain a canal for the reception of the nerves of the tail. These vertebræ are long, firm, cylindrical little bones, slightly thickening at both ends, which are only attached to each other by a cartilaginous fibre.

The Bones of the Chest.—The ribs and the sternum form, with the dorsal vertebræ, the bony foundation of the chest. The first, with the costal cartilages, form the side walls, the breast-bone the lower wall, and the dorsal vertebræ the upper division. The ribs are long, flat, rather crooked bones, which are articulated in the upper portion with the dorsal vertebræ, and terminate below in the costal cartilages. By means of the latter, some of them come into direct contact with the sternum (8 pairs of true ribs), but the remainder of the costal cartilages do not reach the breast-bone, but are only loosely fastened to each other (five pairs of false ribs). The sternum is a single spongy bone, consisting originally of seven (in older animals of two) parts connected by a joint, and having at its lower end a large, almost circular flat piece of cartilage—the shovel-cartilage.

The bones of the pelvis form, with the sacrum, the lower foundation of the pelvic cavity and the point of attachment for the hind limbs. They consist of the two pelvis bones, each of which is made up of the ilium, the pelvis, and the ischium. The cup-shaped cavities receive on both sides the joint heads of the thigh bones.

Bones of the Limbs.—The fore-limbs are only united to the trunk by muscles and sinewy extensions. The bones which compose them are the shoulder-blade bone (*scapula*), which is completed in its upper portion by a large supplementary cartilage—the scapulary cartilage. The outer surface is divided into two halves (back and front) by the

edges of the blade bone. The shoulder-blade is connected by a shallow articular foss with the joint head of the second bone, the shoulder-bone, the foundation of the upper arm, thereby forming the shoulder joint. The shoulder-bone possesses a row of strong processes, serving for the fastening of the muscles. The perfectly vertically-placed fore-arm is formed by the fore-arm bone or radius and the elbow, which is placed in a backward and outward direction. The knee of the fore limb consists of six small bones which lie in two rows, one immediately over the other; in the upper row there are four bones—the unciform bone, the polygonal bone, the cuneiform bone, and the cuboid bone; in the lower row are only two—the lunar bone and the conical bone. Below the knee is the shank bone, forming with the large pastern the fetlock joint; next the small pastern or coronet bone, and the pedal or foot bones, with the navicular bone at the back, all these are divided (cleft) into two portions up to the fetlock joint, at the back of which are the sessamoid bones. The two dew claws contain small irregular bones, which are not connected with the skeleton. The hind limbs consist of the following bones:—The upper thigh bone, joined to the pelvis, and forming at its lower end, with the tibia and patella, the stifle joint.

The leg-bone (tibia) extends from the stifle to the hock joint, which is composed of several small bones, including the calcis, which forms the point of the hock, the astragalus below it, two rows of cushion bones, constructing together a very complex joint. Below the hock the arrangement of the shank bone pasterns and bones of the foot is the same as at the fore extremity.

INTERNAL ORGANS.

The internal organs include the central organs of the nervous system, circulatory and respiratory systems, the principal organs of which are situated in the cavity of the chest; the organs of digestion in the abdominal cavity; and the urinary and sexual organs in the cavities of the abdomen and pelvis; and organs of the nerve system in the cranium and vertebræ.

The Nervous System.—The nervous system governs the movements, as well as the functions, of the voluntary and involuntary muscles, and is concerned with consciousness, sensitiveness, and all mental operations.

The central organ of the nervous system is called the brain, and is distinguished as cerebrum and cerebellum. At the base of the brain is the medulla, from which the spinal marrow extends. The brain in the cranial cavity is enclosed by a strong, solid, bony case, and on it depends the so-called mental functions—the will and mental powers. The spinal marrow must be taken as the original source of most of the cerebral nerves, and as the connecting link between brain and spinal marrow; it also governs, as a reflex organ, the respiratory and cardiac motions. The spinal marrow is essentially the connecting organ, and brings about the guidance between the brain and nerves of the spinal cord. This lies, as already stated, in a strong bony tube—the spinal canal formed by the vertebral column. From the brain and spine spread innumerable pairs of nerves, which are called, in so far as they are connected with the voluntary and involuntary muscles, motor muscles or muscles of movement, and, in so far as they conduct to the organs of sensation, are known as sensory nerves.

As in man, so in animals, we find five distinct organs of sense—smell, sight, hearing, taste, and feeling. While the sense of feeling is really distributed all over the body, the other senses are confined to certain parts of it only; the senses of sight, hearing, and smell are limited to one pair of organs, the sense of taste in the tongue to one single nerve. With the ox all sensory organs come into play immediately after birth, even if not to their full capacity, yet sufficiently to enable the young animal to receive outward impressions, and to be conscious of his surroundings.

ORGANS OF SMELL.

The seat of smell is in the mucous membrane covering the inside of the upper part of the nose, and called the olfactory membrane, over which the olfactory nerves are distributed.

THE ORGAN OF SIGHT.

A number of structures are included in the visual system. The eye-ball and its muscles and gland, the orbital cavities, the upper and lower eyelids, which form the eyelid-fissure, the straight eyelashes with their outward direction found on the upper lids, and also the fold of mucous membrane at the inner corner of the eye, and furnished with a supporting cartilage; the nictitans membrane or third eyelid; the lachrymal glands and the eyelid glands, which furnish the necessary moisture. A series of muscles provides for the motion of the eye.

The eye-ball itself is an organ consisting of three concentric membranes, lying one over the other: it contains the optical and sensitive apparatus forming the organ of sight, and through which, by means of the optic nerve at the back of the organ, it is connected with the brain. The separate parts of the eye-ball consist of the outer coat—enclosing the whole eye-ball—of which coat the most important part is the dense, opaque, hard and white membrane (sclerotic coat); while the front part, the transparent tunica or cornea, convex, like a watch glass, appears to be set in the eye, and by reason of its perfect transparency allows the entrance of the rays of light. It also consists of a middle coat, which is again divided into the choroid membrane and the iris. The first named is a very fine membrane, lying between the sclerotic coat and the retina, and is formed of vessels. Before reaching the point of connection with the cornea and sclerotic coat, it is disposed in many folds and forms the ciliary body (*corpus ciliare*)—the furrowed circle surrounding the crystalline lens.

On the inner surface, on an expanded place, is seen a peculiar iridescent lustre, which in the ox changes from a brilliant green to a beautiful deep blue: this spot is called the *tapetum lucidum*. The iris, at its junction with the cornea and sclerotic coat, sinks abruptly down to the axis of the eye, forms here a partition, provided with an opening of a transverse oval in shape, thus dividing the hollow space in the eye-ball into a small front chamber and a larger one behind it, in shape an elliptical disc, covering the crystalline lens from the front. In this opening we also find the pupil, which, according to the action of the light on the eye, shows changing dimensions, that is to say, it contracts in a bright light and dilates when the rays are dim.

The third membrane which contributes to the formation of the eye-ball is the innermost coat or retina, which originates in the optic nerve and represents an expansion of it, which stretches over the vitreous humour to the furrowed circle. This has an extraordinarily complicated construction, and actually forms the most sensitive part of the eye.

The previously mentioned outer coverings of the eye-ball envelop, from the front to the back in their order, the watery fluid of the anterior chamber—the crystalline lens and the vitreous humour. The optical apparatus proper is composed of the transparent cornea and the three last-named organs.

If we look through the transparent cornea into the interior of the eye, we shall see first of all the iris, hanging round the eye, which, by means of its circular and radiate muscular fibres, regulates the falling of the beams of light into the eye, and at the time represents a blind for it. Just behind the iris, the space (pupil) left by these latter, lies the transparent crystalline lens, a solid, soft substance, surrounded by the furrowed circle, and behind this the vitreous humour which fills the whole space behind the eye-ball, and is also clear and transparent. The space between the transparent cornea and iris and crystalline lens is known as the anterior chamber; that lying behind the iris, between it—the crystalline lens and the ciliary body—is called the posterior chamber.

The essential principles of sight are light and a normally formed eye-ball. As soon as dimness in the above-described transparent portions

of the eye, or diseased conditions of the reflecting retina, or of the optic nerve, or of those portions of the brain whence it originates—when these present themselves the power of sight is either partly or entirely suspended.

THE AUDITORY APPARATUS.

The organ of hearing, or ear, has the function of hearing tones and vibrations of sound and bringing them to the consciousness. There is an outer ear, the cartilaginous exterior ear, covered with the outer skin; a middle ear, formed by the cavity of the tympanum; and an inner ear, situated in the stony part of the temporal bone. While the outer and middle ear catches the waves of sound, it conducts the inner, the true organ of hearing, to the brain, by means of the auditory nerves. The outer and middle ears are separated by the tympanic membrane, a tightly stretched thin membrane, which brings about the passage of the sound waves to the so-called bones of hearing, placed in the cavity of the tympanum. The bones of hearing, the hammers, incus sesamoidal bones, and stirrup, continue in the inner ear the vibrations received from the tympanum; the inner ear being divided into vestibule, semi-circular canals, and the cochlea. Here, by means of the so-called labyrinth water, the waves are communicated to the finest branches of the auditory nerves, which convey them to the brain. From the cavity of the tympanum a canal leads into the cavity of the throat—the Eustachian tube.

THE SENSE OF TASTE.

A branch from the inferior maxillary division of the fifth pair of nerves is distributed to the tongue, sides and back of the mouth, conferring on those parts the power to appreciate the flavours of substances introduced into the mouth. It is certain that perfect taste is in some degree dependent on the sense of smell, and a once popular definition of taste described the function as a compound of touch and smell.

THE CIRCULATORY SYSTEM.

The blood consists of a colourless fluid—the blood-plasma—holding in suspension solid particles, the red and white corpuscles. The red corpuscles, which greatly exceed the white in number, are very delicate, and in our domestic animals circular-shaped growths, of which the cells, which have neither nucleus nor membrane, represent the side-view of a stamped disc, in so far as their shape may be compared to pieces of money. The colouring of the red corpuscles depends on the colouring matter in the blood. The white corpuscles are identical with the lymph corpuscles, are larger than the red ones, colourless, also without membrane, spherical in shape, and containing nuclei. They are distinguishable by the adhesive properties of their surface, and by their buoy-like power of movement, that is to say, they have the power of expanding and contracting, by which means they are able to take up the smallest particles of solid matter into themselves.

Between arterial and venous blood there is a distinction. Arterial blood is bright red in colour, which is considered to be due to its greater volume of oxygen, and the action of this on the colouring matter; the quantity of nitrogen in it is also larger than in venous blood, but the mixture of carbonic acid is less. The venous blood is darker, containing more carbonic acid than arterial blood.

As already said, the blood flows through the whole body. This flow is due to the action of the heart chiefly, which first sets the blood in motion. The heart is a hollow, compound muscle, situated in the cavity of the chest, between the anterior lobes of the lungs. It is somewhat upright, sloping in a backward direction; it reaches in front to the third, and at the back to the sixth rib, and its side inclines somewhat more to the left than to the right pectoral wall.

The heart is retained in position partly by the great blood-vessels, which take their rise in it or discharge into it, and which are either fastened to the spinal column or pass on to adjacent organs, and partly by the two layers of the mediastine, which form the so-called pleura

and cover the pericardium, and also by this last being attached to the sternum and diaphragm.

The pericardium, which completely encloses the heart, is a thin but firm skin, composed of two layers, the inner side exuding a slight moisture, the use of which is to keep the surfaces of the heart and pericardium damp and slippery. As already stated, the heart itself is a conical or pear-shaped, muscular, dark red organ, which contains four divisions, separated by solid partitions and partly by valves one from another, the limits of which are discernible by furrows on the outer surface of the heart. These cavities are the two auricles and the two ventricles. The two auricles, right and left, are, like the ventricles, divided by a common partition. They are placed at the basis of the heart, and besides this partition they have side walls, which form, when they bulge out, jagged projections, and are therefore called auricular appendages. In the partition of the auricles lie, partly surrounded by muscular tissue, two heart-bones, one large, one smaller. The two ventricles lie below the auricles, and have much thicker walls of muscular fibre than the last-named. The auricles are connected by the ventricles of their respective sides by a wide opening, while the right and left halves of the heart are completely separated one from another by the partition wall already mentioned. The left side of the heart contains the arterial blood, the right side the venous blood.

The auriculo-ventricular openings are provided with valves on both sides, in order that the blood, streaming from the auricles into the ventricles, as the heart expands, may not at its contraction flow back again into the auricles; the left auriculo-ventricular opening is closed by the so-called two-pointed sail valve, the right by the three-pointed valve (*bicuspidalis* and *tricuspidalis* valves). These are called mitral or sail valves on account of their shape, the effect of which is enhanced because the edges of the valves are fastened to a row of sinewy threads coming from the projections of the muscular inner wall of the heart, that is, the so-called papillary muscles, and thus being kept distended, they appear as unfurled sails. In the same manner the great blood-vessels, the aorta on the left and the pulmonary vein on the right, are provided at their starting point with a valvular system, the so-called semi-lunar valves, which, consisting of three pocket-shaped parts, close firmly together, and entirely preclude any reflux of the blood into the ventricle.

From a purely mechanical point of view, the heart may be compared to a suction and force-pump. The contraction of the heart drives a wave of blood forcibly at certain intervals into the neighbouring portion of the arteries, which are already filled with blood, and thus increase the already high pressure of the blood in such a manner that the blood is forced to move on in the direction of the capillaries. But arteries, capillaries, and veins represent a continuous and unbroken tube-system, of which the beginning and end are found in the heart, so that the flow of blood takes always one and the same direction from the heart, and back towards it. Therefore one speaks of the circulation of the blood, or calls the collective movements of the blood its circular motion.

The accompanying diagram represents the circulation of the blood. From the left ventricle, the arterial blood, specially adapted for nourishment, is rhythmically and forcibly driven out into the great artery (the aorta), which, above the heart, divides into two great branches, the anterior and the posterior aorta. Both these large vessels branch off in a forward and backward direction into a number of smaller arteries, the smallest branches of these dispersing themselves in the capillary net, out of which come forth the roots of the veins. The veins coming from the front of the body unite with the anterior vena cava; those coming from the back, with the posterior vena cava. These two important veins convey the venous blood, which has passed through the capillary net and is no longer fitted to nourish the body, back again to the heart, by discharging itself into the right auricle. Thence the blood is forced into the right ventricle, which, by the contraction of its walls, drives it into the pulmonary artery. This last blood-vessel, therefore, contains venous blood, in spite of its being called

an artery. From the pulmonary artery the blood comes into the lungs, becomes oxygenised here by the atmospheric gas in the respiratory capillary system, bright red in colour, and full of nourishment, and then returns by the pulmonary veins (which, in spite of their name, contain arterial blood) by several branches to the left auricle. From the left auricle, the blood enters the left ventricle, which once more impels it into the aorta.

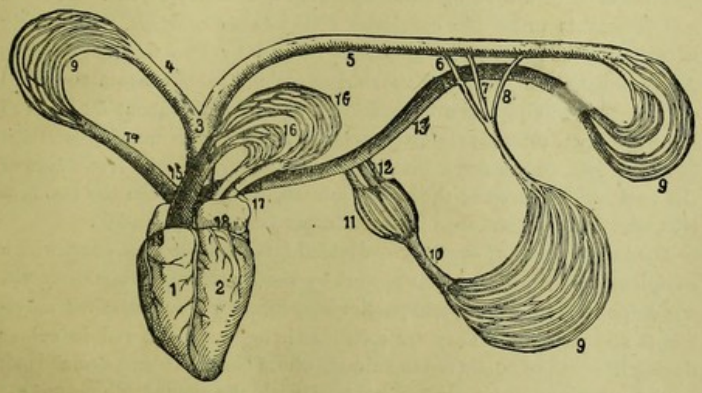

DIAGRAM REPRESENTING THE CIRCULATION OF THE BLOOD.

(1) Right ventricle. (2) Left ventricle. (3) Root of the aorta. (4) Anterior aorta. (5) Posterior aorta. (6) Abdominal artery. (7) Anterior mesenteric artery. (8) Posterior mesenteric artery. (9) Capillary network. (10) Portal vein. (11) Its capillary network in the liver. (12) Hepatic veins. (13) Posterior vena cava. (14) Anterior vena cava. (15) Pulmonary artery. (16) Its capillary network in the lung. (17) Pulmonary veins. (18) Left auricle. (19) Right auricle.

It is usual to distinguish between the greater and the lesser circulations. The first comprises the system of the aorta, capillaries, and vena cava; the latter, the respiratory capillary network, with the pulmonary artery and vein. A subdivision of the systemic circulation is the portal vein system, to which the two mesenteric arteries of arterial blood coming from the posterior aorta conduce. These divide again in the stomach, intestinal canal, in the spleen and in the pancreas, and find themselves, after dispersing there, in the capillary network, together again in the veins, forming the commencement of the portal vein. This latter once more forms a capillary network in the liver; the veins formed from this network unite as hepatic veins, and discharge into the posterior vena cava. After the foregoing exposition, it is plain that no mingling of the arterial with the venous blood during the circulation is possible; accordingly, one speaks of an arterial circulation and a venous circulation.

As we have seen, the blood is rhythmically and forcibly driven out of the left ventricle. This impact of the wave of blood on the sides of the vessels is called "pulsation;" whilst the palpable beating, even in the vicinity of the heart, caused by its contractions, is designated "throbbing." If arteries, even those distant from the heart, sustain injury, the blood flows out in jets and spurts, whereas it pours out slowly and regularly from the veins. The number of respirations depends on age, but there are considerable variations in individuals of the same age. They range in quite young oxen from 100 to 120, later in life they drop from 70 to 80, and, finally, in full-grown animals, from 50 to 60 pulsations a minute. Movement, running, excitement, and illness exercise great influence on the number of respirations. During sleep the pulse generally drops below the normal number somewhat.

If, in the preceding, we have already made mention of the greater number of large blood-vessels, in the accompanying schedule to Plate III. the names of the blood-vessels are given.

LYMPH VESSELS.

In connection with the system of blood-vessels may be described the construction of the lymphatic vessels corresponding with that of the veins. They are thin-walled tubes, which originate with open ends in the tissue spaces of the animal body; then receive, in a capillary network,

the lymph collecting in the spaces of the tissue, and in larger superficial or deep-seated branch-vessels; finally, however, in two principal branches, move towards the right and left auxillary veins. The first chief branch is known as the lacteal duct, the second as the right bronchial root. All the lymphatic vessels, before they discharge in one of the chief branches of the vascular system, must pass through one or more lymphatic glands, an exceedingly large number of which are attached to fixed parts of the body. There is a difference between the "pure lymph," which resembles blood in its consistency, and lymph formed by the action of the glands of the stomach and intestinal canal during the process of digestion, which is known as milky fluid (chyle). The fluid, taken up by the lymph and chyle vessels, serves to thin the blood; and, on the other hand, alters the composition of it. Animals with whom the contents of the lacteal duct was drawn off for a few days, lost considerably in weight, and nearly died.

THE RESPIRATORY SYSTEM.

In the respiratory organs, the change of gases occurs between the blood of the animals on the one hand and the atmospheric air, in which the animals must live, and only can live, on the other hand. The change of gas consists in this: the carbonic acid gas accumulated in the blood is discharged, and the oxygen necessary to life is conducted into the lungs, when the exchange takes place.

Respiration is effected by means of the movable walls of the pectoral cavity, which, through more or less regular contraction and expansion of the muscles of breathing, cause expiration and inspiration. The air-tubes lead to the lungs. To the air-passages belong the nasal cavities, with the nasal openings, the cavities of the mouth, throat, larynx, and the air-tubes and their extensions.

There are two nasal cavities, divided by the cartilaginous bridge of the nose, and in the middle and upper portions filled out by the ethmoid muscles, fine plates of bone, twisted many times about each other and covered with mucous membrane, the principal use of which is to prevent the entrance further into the air-passages of solid particles of dust and foreign bodies, and by means of their numerous blood-vessels to warm the inhaled air. Through the cavities of the mouth and throat, the inhaled air gets to the larynx. This lies between the branches of the lower jaw, forms the foundation of the laryngeal cavity and the commencement of the windpipe. Its foundation is composed of five movable, interwoven cartilages, the thyroid or scutiform cartilage, the annular or cricoid cartilage, the arytenoid and the epiglottis. Muscles and ligaments unite the epiglottis with its surroundings, particularly with the hyoid bone. The glottis is formed by two folds of mucous membrane in the inside of the larynx, which folds contain the vocal cords. The windpipe is a tube, formed by a row of about 50 rings of cartilage, open towards the back, which begins at the annular cartilage of the larynx, passes down into the pectoral cavity on the front part of the neck, and in front of the spinal column, enters between the two first ribs, and ends at the lungs in three larger branches (bronchi).

The lungs, a pair of organs, are divided into right and left lung, which completely fill the space left vacant by the heart, larger blood-vessels, windpipe and œsophagus, and participates in every way with their movements and changes. They are soft, elastic organs, dark red in colour during life, and of a pale red in animals whose blood has been drained off; having a smooth outer surface, covered with the pleura, which appear correspondingly on the pulmonary lobes. The left lung is divided into two or three lobes, the right lung into three or four; among the latter is reckoned the so-called middle lobe. The branches of the windpipe, as they pass on from the windpipe into the lungs, divide into the substance of the latter, becoming continually smaller until the finest end at last in little blind cells, lying close together like a bunch of grapes. These little bags, air-cells, are surrounded on the outer surface by an exceedingly fine capillary net, which, originating in the network of vessels of the pulmonary artery, supplies itself with venous blood, containing carbonic acid gas. Thus in the lung-cells takes place the change of gases used by the blood, the carbonic acid gas being, as already stated, given off

by exhalation, and the oxygen from the air breathed in being taken up. By this process, the used-up blood coming out of the right ventricle, is again transformed into arterial blood and conducted through the pulmonary veins to the left auricle. Besides this pulmonary respiration, also called external breathing, there is also an internal, or breathing of the tissues, by which the blood in the capillaries of the body again transforms the oxygen taken up by the external breathing into carbonic acid gas. The breathing (respiration) takes place by means of the muscles of the chest walls and the principal breathing muscle, the diaphragm.

In quiet, normal breathing, air is taken in and given out only through the nasal cavities, but in laboured and accelerated respiration, through these and also through the cavities of the mouth and throat.

The number of breaths per minute varies according to age, sex, movement, rest, if awake or asleep, &c.: they vary from 20 to 50.

The voice of the ox is called bellowing and lowing, in the calf bleating. The vocal organ is in the larynx; to bring this into play, the glottis must be narrowed by tension of the vocal ligaments. Further modifications of breathing are panting, coughing, sneezing, snorting or snuffing, yawning, sighing, groaning, smelling, scenting, and sniffing.

DIGESTIVE SYSTEM.

The organs of digestion, beginning at the lips and mouth and terminating the further end of the intestinal canal, present a channel of unequal dimensions, the interior lined throughout with a mucous membrane, which contains the most dissimilar glands. As complements of the digestive organs, must be reckoned the salivary glands, and the pancreatic gland, which bring their secretions to them. Under the mucous membrane, as far as the entrance of the œsophagus into the stomach, there are embedded voluntary muscles, and from that point involuntary muscles in layers. In the abdominal cavity, the whole canal is covered with a serous membrane, the peritoneum.

The alimentary organs are again divided into three parts; the receiving organs (cavities of mouth, throat, and the œsophagus), the stomachs, and the intestinal canal. After the food has been seized and torn up by the incisors and the tongue, or, if in the stable, when it has been taken up by lips and tongue, it passes, assisted by the last-named organ, to the molars or grinders, situated at the middle and back of the mouth, there to be ground into smaller pieces, helped by the juices of the salivary glands—the saliva. The cavity of the mouth is bounded below by the lips, at the sides by the cheeks, towards the front by the palate, and at the top by the palatal sails.

After this first incomplete mastication, the mouthful is shaped by tongue and cheeks, pushed to the cavity of the throat and through into the pharynx, which conveys it to the first stomach by means of a wave-like movement, visible at the left side of the neck. The stomach, or rather, in the ox, the fourfold stomach, forms the second portion of the digestive canal.

The stomachs, like the intestines, lie in the abdominal cavity, which contains all the digestive organs. The abdominal cavity is bounded by some of the dorsal vertebræ above, and the lumbar vertebræ with their oblique processes, and the front portion of the ilium; at the sides by the last posterior ribs, with their cartilages; and below, by the lowest portion of the sternum, with its shovel-shaped cartilage.

The stomach is, in the ox, by far the largest organ of the body, and is a membranous bag, consisting of four parts, the front of which reaches to the diaphragm,—the back, to the pelvic cavity, touches the spinal column above it, and is borne on its under side by the abdominal muscle and integument. It occupies almost the whole of the front portion of the abdominal cavity, as well as the left half of the back part. The œsophagus discharges into the upper front part of the stomach, on the border line between the first and second stomach.

The stomach consists of three layers of membrane one over the other:—the covering of the peritoneum; the partial very strong muscular coat and the mucous membrane, studded in the three first stomachs with innumerable ragged little tufts, and in the fourth with numerous glandular organs.

The first stomach, called the "paunch," is in the full-grown animal by far the largest division of the stomach; the next following, the "reticulum," which is also called "honeycomb-stomach," from the numerous meshes, some five-sided, some six-sided, visible on the upper inner surface, forms the smallest division; the third stomach, on account of its closely folded layers of mucous membrane, is known as maniplies or omasum stomach; the fourth, the maw, or rennet-bag, or abomasum, the chief organ of stomachic digestion, forms the passage to the intestinal canal. In young animals, who still live on milk or its substitute, and in whom no chewing of the cud takes place, the fourth stomach far exceeds the others in size. While the three first stomachs are without glands, having in their place, as already mentioned, a number of small secreting tufts on the mucous membrane, the mucous membrane of the rennet-bag is lacking in these, is soft, velvety, of a deep red colour, and lies in many longitudinal folds. It is unusually rich in glandular organs, both gastric glands and mucous glands. The first-named secrete the gastric juices necessary for digestion, while the latter cover the mucous membrane with a thick mucus, thereby giving it its slippery character. The functions of each division of the stomach have been already described in the general portion, but it may still be mentioned that the most important constituents of the gastric juice are pepsine and hydrochloric acid, and that by it the solution of the albumenoids is effected.

RUMINATION.

In all ruminants, the course of the food, after mastication and swallowing, is modified by rumination, or chewing the cud, which is effected by regurgitation of the partly-chewed mass from the first stomach, rumen, or paunch, passes into the mouth for further mastication.

When the rumen is sufficiently filled, the ox rests from feeding, and proceeds to chew the cud. A looker-on can see the small mass of food forced up the swallow by the contraction of muscular walls of the rumen, aided by the double circular order of muscular fibres of the œsophagus. After re-mastication and further mixing with saliva, the mass is again swallowed, and, according to a once favourite theory, carried into the second stomach, and thence on to the third and fourth stomachs. It is, however, more likely that everything which passes down the swallow goes into the rumen, and from it into the other compartments of the stomach, on its way to the intestinal canal.

The intestine, which is over twenty times the length of the body, begins at the outlet (*pylorus*) of the fourth stomach, and ends at the anus. Because of the varying size of the tube and the difference in its mucous membrane, it is divided into two different parts; the first part being the small intestine, the hind part the large intestine. The first-named has three subdivisions—the duodenum, jejunum, and ileum. The great intestine is divided into the cæcum, colon, and rectum. The walls of the intestinal tube are also composed of three membranes—the covering of the peritoneum, the muscular and mucous membranes. With the exception of a small portion of the duodenum, the whole intestinal canal hangs on a common mesentery, formed by a doubling of the peritoneum, and which bears in and on itself the arterial and venous blood-vessels, and a strong network of lymphatic vessels and glands. The small intestine is formed of a large number of loops, thin and transparent throughout; the mucous membrane has numerous folds and tags, interspersed among the many glandular organs; as also in the jejunum are imbedded the "solitary follicle," the "Peyer" glands, the Brunner and Liebkühn glands—the secretory organs of the intestinal tube. About 70 centimetres behind the pylorus, the gall-duct penetrates the duodenum, coming from the liver; further towards the back, the outlet of the pancreatic gland discharges into it. The large intestine is much shorter than the small one; the different portions pass imperceptibly one into the other, without any noticeable narrowing.

The cæcum is the broadest part of the intestinal tube, and has at the entrance to the ileum a valve; its walls, by reason of the stronger

muscular sheath, are somewhat thicker than those of the small intestine. Like this latter, it has oblique folds of mucous membrane, and has strings on its outer surface. The colon has a smooth exterior, and its mucous membrane small oblique folds. The rectum passes to the back under the spinal column, and terminates in the anus, which, closing by means of constrictor muscles, prevents the involuntary evacuation of the contents of the bowels. Both the stomachs and intestinal canal are in a great measure kept in place by the organs formed by the folding over of the peritoneum, by the plexus and mesentery, in such a way that the freedom of movement in the intestinal tube, the so-called peristaltic movement, is not hindered. In fat animals, large masses of fat lie round the plexus (*omentum? epiploon?*) and mesentery. The length of the whole intestinal tube varies very much. While the small intestine has a length of from 36 to 45 metres, according to the size of the full-grown animal, the length of the great intestine is limited to from 9 to 11 metres.

Two already named large glandular organs, the liver and the pancreas, play an important part in digestion. The first, lying immediately behind the diaphragm, secretes the bile, which is conveyed through the biliary gall-duct to the duodenum; the latter furnishes the pancreatic fluid, which also goes into the duodenum through the pancreatic duct. The bile assists materially in the absorption of fat; it also exercises a certain antiseptic action, while the pancreatic fluid continues the fermentative action set up by the saliva. The liver is a large reddish-brown gland, rectangular in shape, somewhat concave towards the front, and slightly flattened at the back. It is held by several ligaments to the diaphragm, and divided into two halves by fissures. On the posterior surface of the liver, near the lower part, is seen the reservoir for the gall and the gall-bladder; the biliary duct leads from it; and this, in its subsequent union with the hepatic duct, forms the common biliary duct, which conveys the bile into the duodenum.

By means of the secretions of the above-mentioned gland of the mucous membrane of the intestinal canal, and also through the mingling of the secretions of the liver and pancreas, all solid elements of food become dissolved during their passage through the intestinal tube, and made fit for absorption—so that, in the last portion of the rectum, the excrement *(fæces)* alone collects, which is cast forth in more or less distinctly-shaped balls.

The spleen has nothing directly to do with the digestion; but it is necessary to mention it, as it lies directly on the left side of the paunch, and is attached to it. Its functions are not well understood; but most probably these are more concerned with the circulatory than the digestive system.

URINARY SYSTEM.

Urinary organs.—The urinary organs comprise the kidneys, which separate the urine from the blood; the ureters, which convey it to the bladder; and the urethra, to carry it from the body. There are two kidneys, each formed of many lobes, and are secretory glands, oval in shape, brownish-red in colour, and of rather a firm consistency. They lie outside the peritoneum in the abdominal cavity, in the region of the fore part of the upper loins, right and left of the spinal column. In dissecting the kidneys, a cortex and marrow substance are distinguished clearly, to the number of from 15 to 18, even to 30 renal lobes in each kidney. In addition to a peculiar, web-like, detachable membrane, the kidneys are enveloped and kept in place by a strong fibrous membrane and masses of fat. In front of the kidneys lie the renal capsules.

The urine, secreted in the so-called Malpighian bodies and uriniferous tubes, collects in the pelvis of the kidney, and is conveyed through the ureters (two fine membranous tubes, which form the immediate continuation of the kidney-pelvis) into the bladder, a somewhat elongated, round membranous receptive organ. Here it collects, and is retained by the sphincter muscle of the bladder until discharged—in male animals through the urethra contained within the penis; in the female it is discharged through the vagina.

ORGANS OF GENERATION.

The generative organs of the male consist of the testicles, with their coverings and ducts, and their accessory glands. The first are formed by the testicles, the spermatic ducts, the membrane dividing the testicle and spermatic cord, and the scrotum; the latter consist of the spermatic vesicle, the prostrate glands, and Cowper glands. Among the male sexual organs are counted the penis, its muscles, and sheath or fore-skin.

The female organs of generation are divided into the ovaries, the Fallopian tube, the womb (uterus), the vagina, and the clitoris, and the external parts or vulva.

The mammary glands, which are much more developed in the female than in the male, form, with the skin which covers them, the udder; they stand in such direct relation to the sexual organs of the female, that they must be considered in connection with them. The udder is situated between the two thighs, and extends, according to its degree of expansion, from the pubis to the navel; it is divided into right and left halves each of which has two large cone-shaped teats further into quarters The glandular substance is greyish-red in colour, and composed of a number of glandular cells, which unite into glandular vesicles and tiny lobes, and forms a secretion, which yields the first and best adapted nourishment for the newborn animal.

The milk produced by the gland collects in ducts, which unite to form gradually larger branches, and discharge into the lacteal receptacle, a larger cavity situated over the teats.

A few days before delivery, the udders of pregnant animals begin to get firmer and more full of blood, and give off when milked a cloudy, serous fluid, which, gradually becoming thicker, is called birth-milk or colostrum, in contradistinction to the later so-called mature milk, which is essentially of a different quality. This latter forms an emulsion, a white, opaque liquid, representing under the microscope a colourless secretion, clear as water, in which float innumerable minute globules of fat, which give a white colour to the milk. Ordinarily the cow has one calf every year, but not unfrequently there are two at a birth. The period of pregnancy lasts about ten lunar months, or 284 days. It is occasionally retarded for some days, or even weeks. The shortest recorded pregnancy was 240 days, and the longest 311 days.

Parturition occupies much longer in the cow than in the mare, but in most cases it is accomplished without any assistance being required.

EXPLANATION OF THE PLATES.

PLATE I.—DIVISIONS OF THE BODY OF THE COW.

HEAD.

1. Back of Head.
2. Frontal crest or protuberance.
3. Horns.
4. Ears.
5. Forehead.
6. Bridge of nose.
7. Nostrils.
8. Mouth, with upper and lower lips.
9. Chin.
10. Throat.
11. Cheeks.
12. Eyes and eyelids.

NECK.

13,14. Nape of the neck.
15. Throat.
16. Dewlap.

TRUNK.

17. Withers.
18. Back.
19. Loin, or kidney region.
20. Walls of chest.
21, 22. The breast.
23. Belly.
24. Flanks.
25. Upper part of flank.
26. Rump.
27. Croup.
28. Haunches.
29. Root of tail.
30. Tail.
31. Tuft.
32. Udder, with the teats.
33. Perinæum, with lacteal shield.

FORE LIMBS.

34. Shoulder.
35. Point of shoulder.
36. Fore-arm.
37. Elbow.
38. Knee.
39. Shin (metacarpal).
40. Fetlock-joint, with the dew-claws.
41. Pastern.
42. Coronet.
43. Hoofs.

HIND LIMBS.

44. Upper thigh.
45. Hip-joint.
46. Stifle-joint.
47. Lower thigh.
48. Hock.
49. Point of hock.

From the hock downwards, the descriptions are the same as in the fore-limbs.

PLATE II.—THE SKELETON.

HEAD.

1. Upper jaw.
2. Lower or under jaw.
3. Occipital bone.
4. Frontal protuberance.
5. Horn cores.
6. Frontal bone.
7. Lachrymal bone.
8. Malar bone.
9. Zygomatic bone.
10. Nasal bone.
11. Great maxillary bone.
12. Six upper molars.
13. Great maxillary bone.
14. Temporal bone.
15. Orbital cavity.

In the lower jaws (2) are—

16. The six lower molars.
17. The eight incisors.

TRUNK.

18-24. 7 cervical vertebræ, the first is—
18. The atlas.
19. The axis (or rotator).
25-27. 13 dorsal vertebræ, with
1'-13'. The ribs, of which are named :—
1'- 8'. True ribs ;
9'-13'. False ribs.

The first eight extend to—

38. Breast-bone or sternum.
39-44. 6 lumbar vertebræ.
45. Sacrum.
46-65. 20 coccygeal vertebræ.

The number of these varies from 18-20.

66-68. Bones of the pelvis.
66. Ilium.
67. Ischium.
68. Os pubis.
69. Hip joint.

LIMBS.

70. Shoulder bone.
71. Point of shoulder.
72. Upper arm bone.
73. Elbow-bone (*Ulna*).
74. Fore-arm bone or radius.
75. Elbow-joint.
76. Fore-knee-joint, consisting of—
77. Unciform bone.
78. Polygonal bone.
79. Lunar.
80. Scaphoid.
81. Semi-lunar bone.
82. Magnum.
83. Metacarpal.
84. Rudimentary sphenoid bones.
85. Sesamoid bones.
86. Pastern bones.
87. Coronet bones.

The Skeleton—*Continued.*

88. Hoof-bones.
89. Navicular bone.
90. Femur (thigh-bone).
91. Tibia.
92. Patella.
93. Stifle joint.
94. Hock. This comprises—
95. Calcis (heel-bone).
96. Astragalus.
97. Scapho-cuboid.
98. The first cuneiform bone.
99. The second and third cuneiform bones. From the hock downwards, the bones are the same as on the fore limbs.

PLATE III.

Abbrev.: *H.* Heart, *T.* Trachea or Windpipe, *S.* Œsophagus, *L.* Liver, *M.* Stomachs, *Mz.* Spleen.
The arteries are traced in red, the veins in blue.

A. ARTERIES.

1. Aorta, or principal artery.
2. Left coronary artery of the heart.
3. Anterior aorta.
4. Posterior aorta.
5. Left inominate artery (section).
6. Right inominate artery, giving off
7. The left carotid artery.
8. The right carotid artery, and
9. The right inominate.
   The carotid arteries start from a common root.
10. Branches for the windpipe, œsophagus, and neighbouring muscles, also
11. The interior parotid gland artery.
12. The upper thyroid artery, from which springs
13. The pharyngean artery, which gives off branches to the thyroid gland, pharynx, the œsophagus, and the larynx.
    At the parotid gland, the carotid arteries divide into
14. The occipital artery (first portion only visible).
15. The external maxillary artery.
16. The internal maxillary artery, and
17. The lingual artery.
    From the external maxillary come and are visible
18. The face artery.
19. Coronary artery of the upper lip, and
20. Coronary artery of the lower lip.
    From the inner maxillary artery come and are visible
21. The temporal artery with its branches.
22. The labial portion of the lower dental artery.
23. The upper lip artery.
24. The lower eyelid artery, and artery in bridge of nose.
    From the right inominate artery come
25. The anterior intercostal artery (section).
26. The oblique cervical artery.
27. Deep cervical artery.
28. The vertebral artery.
29. The inner pectoral artery.
30. The oblique shoulder artery (not visible).
31. The outer pectoral artery, and
32. The axillary artery (not visible).
    This last forms the continuation of the inominate artery, and gives off (not visible on the plate) the superior scapular and inferior scapular arteries, the lower shoulder artery, with the back entwined arm-bone artery and deep brachial artery, as well as the entwined scapular artery. In its further course, the axillary artery continues as brachial artery. This gives off also (not seen on the plate) the front entwined arm-bone artery, side artery of the elbow, the lower side artery of the fore-arm, and the external interosseous artery. About the middle of the fore-arm the brachial artery divides into the radial artery and elbow artery. The elbow artery is only a small vessel.
33. Radial artery.
34. Large metacarpal artery.
35. Small metacarpal artery.
    The posterior aorta is divided into thoracic aorta and abdominal aorta. The first gives off
41. The œsophagian artery.
42. The bronchial artery.
43. Ten pairs of intercostal arteries.
    From the abdominal aorta come
44. The diaphragm arteries.
45. The cœliac axis, which gives off the upper, middle, and lower gastric and splenic arteries, and the hepatic artery. Also the
46. Anterior mesenteric artery, which divides into three principal branches—the colon artery, with the iliocœcal artery; in the middle branch, which goes to the lower portions of the colon, to the jejunum and small intestine; and the lower branch, which also goes into the small intestine.
47. Arteries of the kidneys.
48. The spermatic arteries.
49. The posterior mesenteric artery, which divides into the posterior colon artery and hæmorrhoidiæ.
50. The six pairs of lumbar arteries.
51. Arteries of the thigh.
52. The two pelvic arteries.
53. The middle sacrum artery.
54. The abdominal artery.
55. The artery of spermatic cord, external pudic and epigastric.
56. Artery of the abdominal integument.
57. Posterior circumflex artery.
58. Branch of obturator artery.
59. The femoral artery.
60. The inner skin artery, with the external and internal hock arteries. At this point the upper thigh artery divides into
61. Posterior tibial artery, and
62. Anterior tibial artery.
63. Metatarsal artery.
64. The tarsal artery. From the hock downwards it receives the name of metatarsal artery.
65. Plantar artery.
    The two pelvic arteries (52) give off—
66. The hypogastric artery in the adult, giving off the anterior bladder artery.
67. The ilio-lumbar arteries (section).
68. The tail arteries.
69. The muscular arteries.
70. Muscular branch of obturator arteries.
71. Obturator artery.
72. Internal pudic.
73. The pulmonary artery, carrying venous blood to the lungs (*see* letterpress).

B.—VEINS.

74. The anterior vena cava brings the blood returning from the front part of the body, back into the right auricle. The two principal vessels aiding in its formation are:—
75. Jugular vein. It receives, in addition, a set of smaller veins, flowing off with the arteries, and taking their names from them. It also receives from the region of the posterior aorta the great azygos,
76. Which is composed of the intercostal veins and veins of the air-passages.
77. The posterior vena cava collects the blood flowing back from the posterior parts of the body, and forms again in conjunction with those veins coming from the arteries and named after them, the veins of the sacrum — ilium, pelvis, loins, spermatic, kidneys, etc., and
78. The veins of the liver, which convey back the blood from the capillary network system,

PLATE III.—*Continued.*

79. Formed in the liver by the portal vein, in three or four principal branches and several smaller stems.

80. The portal vein is composed of the posterior and anterior mesenteric, gastric, splenic, and pancreatic veins, with their branches.

PLATE IV.—THE MUSCLES.

1. Levator labii superioris alœque nasi.
2. Zygomaticus.
3. Proper elevator of the upper lip.
4. Pyramidal muscle of the nose.
5. Lachrymalis.
6. Depressor muscle of the under lip.
7. Masseter.
8. Sterno maxillaris.
9. Its sinew, touching on the branch of the lower jaw.
10. Orbital cavity part of the circular muscle of the eyelids.
11. Eyelid portion of the same.
12. Superior abductor of the ear (behind).
13. Middle abductor of the ear.
14. Inferior abductor of the ear.
15. Abductor muscle of ear.
16. Abductor of ear.
17. } Of the muscles common to head
18. } and neck.
19. }
20. Mastoid portion of the sterno maxillary muscle.
21, 22. Great Pectoral } Of the neck-
23. Anterior Pectoral } band shoulder muscle.
24. Lower elevator of the shoulder-bone.
25, 26. Trapezius.
27. Anterior } Portion of long brachial
28. Posterior } extensor.
29. External (cannot see member).
30. External head of triceps extensor brachii.
31. Great head of triceps extensor brachii.
32. Scapular ulnaris.
33. Latissimus dorsi.
34. External oblique of abdomen.
35. Serratus magnus.
36. Rectus muscle.
37. Great extensor of metacarpus.
38. Common extensor of the digits.
39. Extensor of external digit.
40. External flexor of metacarpus.
41. Flexor of foot.
42. Oblique extensor of metacarpus.
44. Deep flexor of toes.
45. }
46. }
47. } Tendons.
48. }
49. }
50. }
51. Sinew of inner hoof extensor.
52. Annular ligament of fetlock.
53. Superficial gluteus.
54. Tensor vaginæ femoris.
55. Rectus femoris.
56. Biceps femoris.
57. Posterior portion of biceps.
58. Semitendinosus.
59. Portion of gluteus.
60. Curvator of tail.
61. } Flexors of foot.
62. }
63. Abductor.
64. Peroneus.
65. Soleus.
66. Gastrocnemius.
67. Extensor communis.
68. } Extensors.
69. }

PLATE V.—THE INTESTINES, AND PART OF AN OBLIQUE SECTION OF THE BODY.

1. Cerebrum.
2. Cerebellum.
3. Pons Varolii.
4. Medulla oblongata.
5. Spinal marrow.
6. Section of cervical-dorsal-lumbar, sacral and coccygeal vertebræ.
7. Ligamentum nuchæ.
8. Turbinated bones.
9. Pharynx.
10. Entrance of the larynx.
11. Windpipe or trachea.
12. Thyroid gland.
13. Bronchi, and their division in lungs.
14. Left lung.
15. Right lung.
16. Wall of pectoral cavity from inside.
17. Tendinous portion of the diaphragm.
18. Muscular part of same.
19. Left (arterial) ventricle from outside, and left auricle over it.
20. Right (venous) from without and above it, the right auricle.
21. Pulmonary artery, coming from the right ventricle.
22. Aorta, coming from the left ventricle.
23. Right auricle.
24. Right ventricle from within.
25. Left auricle ,, ,,
26. Left ventricle ,, ,,
27. Chordæ, tendinous fibres of the valves in left and right ventricles.

DIGESTIVE ORGANS.

31. Cavity of the mouth, with the six grinders.
32. Tongue.
33. Palate, with its ridges.
34. Pharynx.
35. Cervical, and pectoral portion of œsophagus; after piercing the diaphragm, it enters
36. The first stomach.
37. Its left or upper bag.
38. Its right or lower bag.
39. Supports of the paunch.
40. Paunch papillæ.
41. Opening of the œsophagus.
42. Fore }
43. Middle } division of the paunch.
44. Back }
45. Spleen.
46. Opening into the second stomach.
47. Second compartment of stomach, or reticulum.
48. Its meshes or cells.
49. Third compartment of stomach or omasum (book, tripe).
50. Its leaves.
51. Fourth compartment of stomach (abomasum).
52. Its folds of mucous membrane.
53. Pylorus (passage into intestinal canal).
54. Duodenum.
55. Mesentery.
56. Jejunum.
57. Ilium.
58. Its discharging into cæcum.
59. Cæcum far out of its proper place.
60. Colon.
61. Rectum.
62. Anus.
63. Liver (drawn at the back of the diaphragm).
64. Right }
65. Left }
66. Spigelian } lobes of the liver.
67. Polygonal }
68. Gall-bladder.
69. Biliary ducts of liver.
70. Biliary duct of bladder.
71. Common biliary duct, conveying the bile to the duodenum.
72. Entrance of posterior vena cava.
73. Mouth of portal vein.
74. Right and left broad ligaments of the liver.
75. Left kidney.
76. Section of this (with pelvis).
77. Right kidney.

The Intestines, &c.—*Continued.*

78. Ureter, going from the kidney basin and leading to
79. The bladder (displaced).
80. Neck of bladder.
81. Vent-opening of bladder in the
82. Vagina.
83. Uterus or womb.
84. The young in position before birth.
85. Umbilical cord.
86. Umbilical vessels, distributed in the so-called "leather skin" (chorion) and branching out into the fœtal membranes.
87. Cotyledons.
88. Neck of uterus.
89. Mouth of uterus (still closed).
90. Abdominal cavity.
91. Cavity of the pelvis.
92. Section of udder.
93. Glandular substance of same.
94. Milk-collecting ducts.
95. Milk-cistern or sinus.
96. The duct of teat.

The Intestines, &c.—*Continued.*

In studying Plate V., 11 must be pushed upwards, 19 to the right, 20 and 21 to the left, then lay them together again and bend slightly to the right, then bend the heart with the right lung upwards. Then, fold the lung down again, bend round the left half of the diaphragm (17, 18) to the left, when the first stomach will first become visible (26) with the spleen (45). The first-named opens from below, and after its inner walls have been examined, must be turned to the right, when the second, third, and fourth stomachs (47, 49, 51) will come into view. These may also be opened from the lower side and laid on the left with the duodenum (54). The mesentery (55), with the jejunum (56), colon (60), and rectum (61) thus exposed, are bent downwards, by which means the cæcum and ilium entering it, are shown by raising them to the right (59). The left kidney (75) is shown in section and pushed up in order to show the right kidney (77) and the course of the ureters (78). The other organs of the abdominal and pelvic cavities are drawn on the flat of the plate, such as the liver (63), uterus (83), the bladder (79), and the vagina (82). Then the organs of the abdominal cavity are replaced in reversed order, Plate IV. being placed on Plate V., Plate II. on Plate III., so that Plate I. appears once again on the top.

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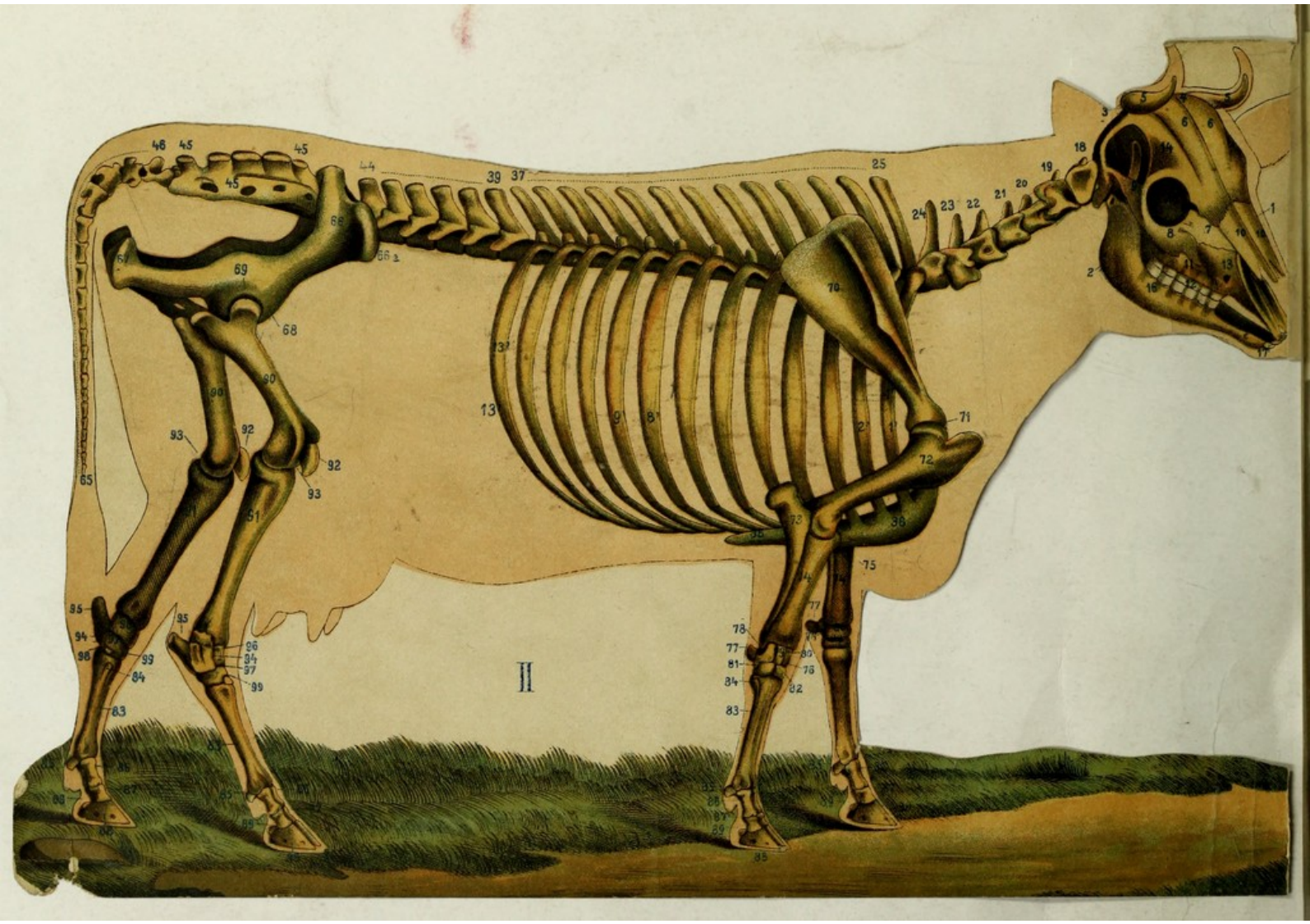
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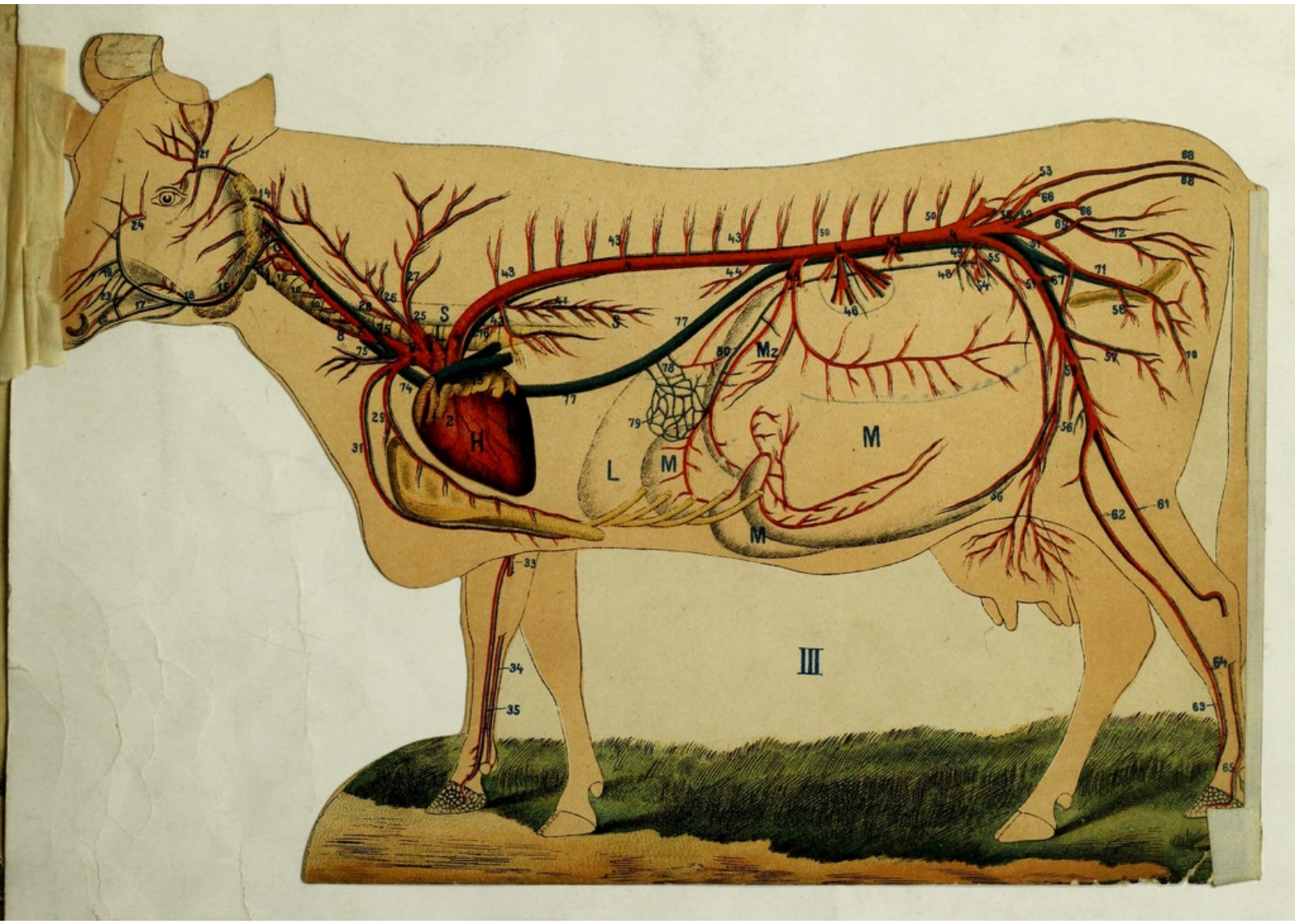
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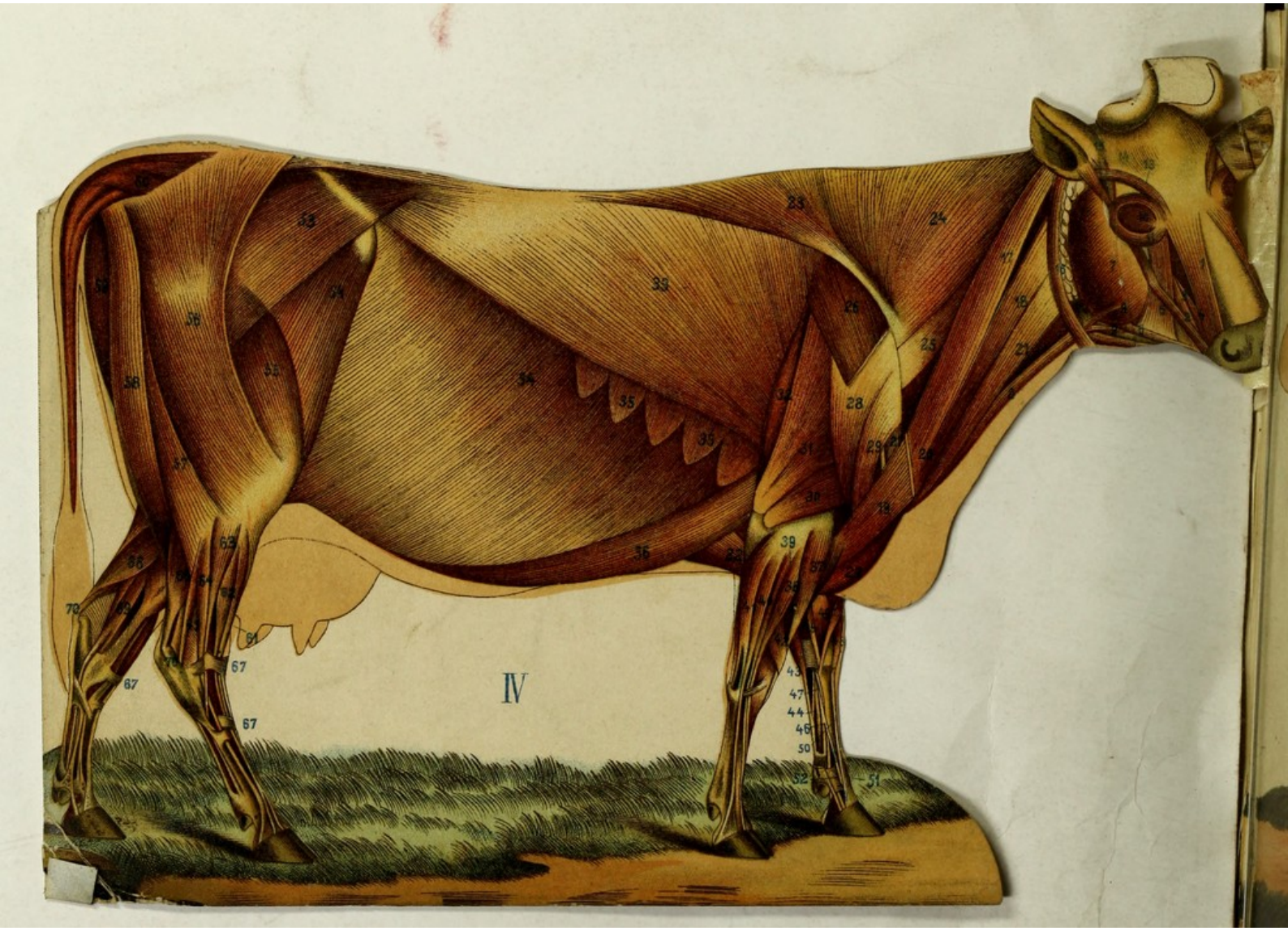
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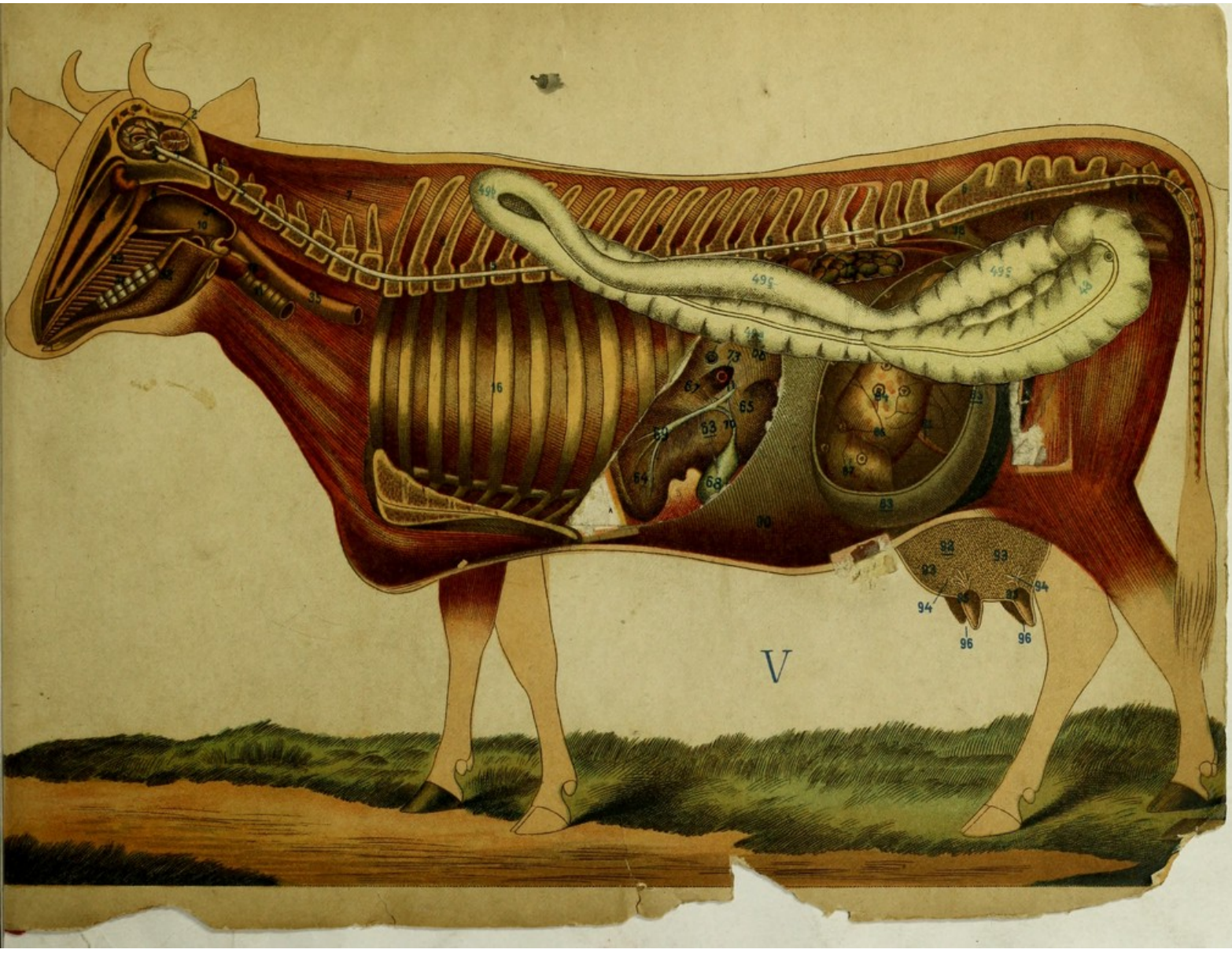
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