DIAGRAMS

OF THE

UDDER OF THE COW, OF THE MARE, AND OF THE EWE.

WITH KEYS AND EXPLANATORY NOTES

BY

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WELLINGTON.
BY AUTHORITY: JOHN MACKAY, GOVERNMENT PRINTER.
—
1904.

Kirk

4/9051

EPUB ISBN: 978-0-908329-83-0

PDF ISBN: 978-0-908332-79-3

The original publication details are as follows:

Title: Diagrams of the udder of the cow, of the mare and of the ewe : with keys and explanatory notes

Author: Wilkie, Henry C. (Henry Charles)

Published: Govt. Printer, Wellington, N.Z., 1904

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THE UDDER OF THE COW, OF THE MARE, AND OF THE EWE.

THESE drawings were made for the purpose of demonstrating in a simple and practical manner the more important anatomical features of the udder, or mammary glands, of the cow, of the mare, and of the ewe.

A general knowledge of the structure of these organs, and the uses of their different parts, is not only needed by the declared student of scientific agriculture, but is of the first importance to all who are concerned either in milk-production or the raising of young farm-stock.

The manner of the formation of the milk, the sources of its various constituents, its passage to the milk-cisterns, the provisions made for its retention, and final withdrawal, have been illustrated and described with a view to making plain to all interested such practical facts as are of importance in every-day farm-life.

FIG. 1. SECTION OF ONE HALF OF THE UDDER OF THE COW.

THIS drawing shows the structures exhibited by a longitudinal section of one fore and one hind quarter of the udder of the cow, in which the blood-vessels have been filled with an injection of a wax mixture, and dissected out to show the directions taken by the larger trunks.

The udder of the cow consists of four quarters and four teats, of which a fore and a hind quarter constitute a lateral half, which has its own fibrous covering, seen at J. The fore and the hind quarters of each side, although functionally distinct, *have no fibrous division between them.*

The udder is held in position firstly by several broad suspensory bands which attach it to the *abdominal tunic,* and secondly by the skin which covers it.

The fibrous envelope of the udder consists of yellow elastic tissue, and is continuous with the suspensory bands.

It is in contact with its fellow of the other side between the two lateral halves of the udder, and all around, it sends into the substance of the gland a number of thin divisions which map out the organ into lobules.

ABDOMINAL.—Latin, *abdomen*, the belly; *tunica*, a coating.
LOBULES.—Diminutive of the Greek *lobos*, a lobe. A subdivision of a gland.

The nutrient or arterial blood is supplied by the *external pudic artery* B1, which passes through a passage in the abdominal wall, termed the inguinal canal, and on reaching the outside, now beneath the base of the mammary gland, it breaks up into two vessels, the *superficial abdominal* G, and the *mammary artery* B2.

The *mammary artery* plunges into the gland-substance, and soon forms six branches, of which the fifth for the greater part of its course follows the direction of the boundary between the fore and the hind quarters.

The veins of the *mammary glands* are divided into *superficial* and *deep*.

The *superficial veins* of the udder anastomose with each other, with those of the quarters of the opposite side, and have also communicating branches with the external pudic vein A1. These veins finally unite in front of the udder to form a very large vessel, the *subcutaneous abdominal*, or *milk vein* H.

The *milk-vein* from each half of the udder unites with its fellow of the opposite side in front of that organ, and immediately afterward divides to form the two milk-veins which pass along the under surface of the abdomen, the wall of which they enter near the sternum.

They then join, or *anastomose* with, the *internal thoracic* veins.

The *deep mammary veins* are satellites of the artery, and unite eventually to form the external pudic vein A1.

The veins of the udder are exceedingly numerous, and so also are the *lymphatic* or absorbent vessels.

The large *lymphatic gland* seen in section at D is situated just behind the external opening of the *inguinal* canal.

It receives a very large number of *afferent lymphatic* vessels from the udder, with a few from the abdominal wall, and the inside of the thighs.

The *efferent lymphatic* vessels, or those leaving the gland, are few in number, there being but five, or never more than six, and they

INGUINAL.—Latin, *inguen*, the groin.
MAMMARY.—Latin, *mamma*, the breast.
ANASTOMOSE.—To unite one vessel with another. Greek, *ana*, through; *stoma*, a mouth.
SUBCUTANEOUS.—Latin, *sub*, under; *Cutis*, the skin.
STERNUM.—Greek, *sternon*, the breast, the breast-bone.
LYMPH.—Latin, *lympha*, water, the fluid which fills the absorbents or lymphatic vessels.
AFFERENT.—Latin, *affero*, I bring.
EFFERENT.—Latin, *ef*, out; *fero* I carry.

enter the abdomen through the *inguinal canal* in company with the external pudic artery, its satellite vein, and the external inguinal nerve. The *external inguinal nerve* is derived from the third *lumbar* pair.

The gland tissue is made up of an enormous number of minute vesicles or *acini*, surrounded by a network of minute blood-vessels or capillaries. These *acini* are clustered round and open into small tubes called the *lactiferous ducts*, the whole being held together by strong connective tissue.

The milk is formed in the *acini* and conveyed to a cavity at the base of the teat called the *galactophorous sinus* (L) or milk-cistern, from whence it is drawn through the orifice at the extremity of the teat (O).

The *galactophorous sinuses* are very small in dry cows, but during lactation are much increased in size, and capable of great distension. They hold the milk which is slowly formed between milkings, or sucking by the calf, but the quantity they contain is not comparable to the amount withdrawn at a milking. A great deal more is contained within the *acini* and *lactiferous ducts*, in addition to which, by reflex nervous action, a quantity of milk is actually formed during the process of milking.

Vesicle.—Latin, *vesicula*, a little bladder. A bladder-like cavity.

Acini.—Latin, *acinus*, a berry. Applied to the enlarged terminals of the lactiferous ducts as indicating their resemblance to the cavity left in a berry when the seeds have been removed.

Lactiferous.—Latin, *lac*, milk; *fero*, I bear.

Galactophorous.—Greek, *gala*, milk; *phoreo*, I carry.

Lactation.—Latin, *lactatum*, to bear milk.

The *mammillæ* or teats have somewhat thick walls, M, and a single orifice seen at O.

The walls are composed of skin, and what is known as *dartoid* tissue, a mixture of elastic and unstriped muscular fibres. The muscle-fibres are both *circular* and *longitudinal*, and the teats are capable of a kind of erection.

At the base of each teat the muscle-fibres are very few indeed, but become more numerous as the free extremity is approached, where they form a *sphincter*, which, by keeping the orifice closed, prevents the passive flow of milk.

A thickening exists at the base of the teat where the *rugæ* are large, and this was formerly regarded as a *sphincter*.

A *sphincter* to close an orifice, however, must consist of very well-developed muscular fibres, which have a circular direction. The number of muscle-fibres in the *dartoid* tissue near the base of the teat is very small, and, moreover, there would be no useful purpose served in having a true *sphincter* in this situation.

The large *rugæ* at the base of the teat probably hold up the milk, when there is very little in the *galactophorous sinus*, by simple passive contact; but when the sinuses are at all distended, as every dairyman knows, the teats are very prominent, and they too are full of milk.

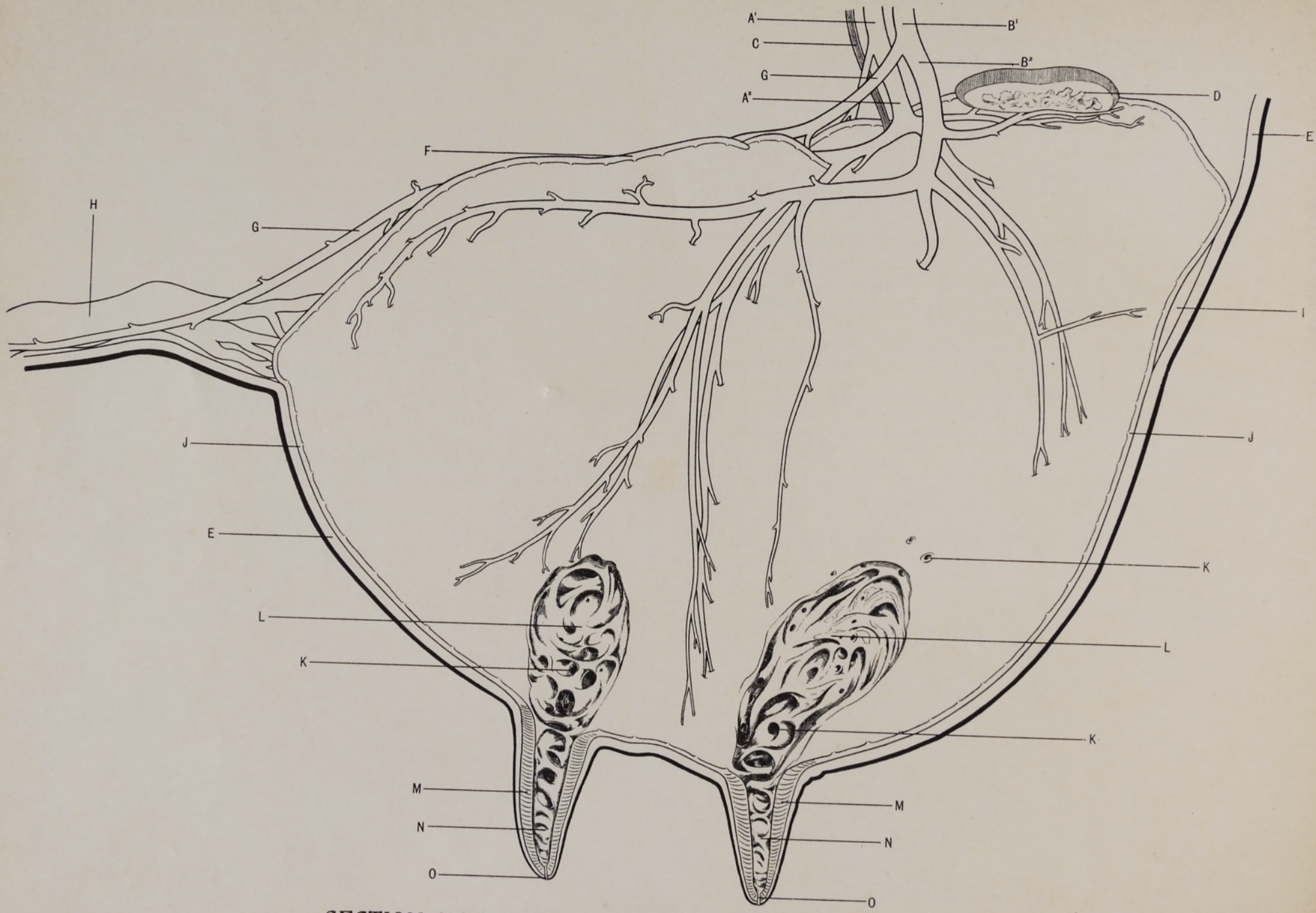
Mammillæ.—Latin, *mammillæ*, nipples or teats.

Dartoid.—Greek, *dartos*, a fleshy covering.

Sphincter.—Greek, *sphingkter*, that which contracts.

Rugæ.—Latin, *rugæ*, wrinkles.

Fig. 1.



SECTION OF ONE HALF OF THE UDDER OF THE COW.

[Drawn by H. C. WILKIE.

Entered at Stationers' Hall, 1903.]

SECTION OF ONE HALF OF THE UDDER OF THE COW.

A1. The external pudic vein.
A2. The mammary vein.
B1. The external pudic artery.
B2. The mammary artery.
C. The external inguinal nerve.
D. Lymphatic gland (in section).
E. Skin.
F. That portion of the fibrous tunic of the udder which is in contact with the abdominal tunic.
G. The superficial abdominal artery.
H. The subcutaneous abdominal vein.
I. Fat.
J. The fibrous tunic of yellow elastic tissue.
K. Orifices of lactiferous ducts, of which there are a very large number opening into the galactophorous sinuses.
L. The milk-cisterns, or galactophorous sinuses.
M. Walls of the teat.
N. Interior of the teat, showing its lining-membrane.
O. Orifice of the teat.

FIG. 2. DIAGRAMMATIC SECTION OF HIGHLY MAGNIFIED GLAND TISSUE.

THIS diagram shows the parts which may be recognised on examination of a very small portion of tissue from the mammary gland, under the microscope.

The full extent of one *acinus* A is seen in section.

The immediate passage out of the *acinus*, the *intralobular duct*, is shown at E, which soon opens into the larger passage D (*interlobular* duct). This latter after receiving in its course the milk from a large number of acini, finally finds its way into the *galactophorous* sinus or milk cistern.

As is seen in the drawing, the *acini* are lined by cells, which have the special property of secreting from the blood (not directly, but through the medium of the lymph which bathes the tissues) the various constituents of milk.

The entire gland is richly supplied with blood conveyed by the minute ramifications of the vessels previously described, thin-walled capillaries which surround each *acinus* in a dense network. Lymph-spaces also surround the acini, and these lead into networks of *lymphatic vessels* of the interlobular connective tissue. From this supply of nutrient material the cells lining the *acini*, by the special selective power with which they are endowed, manufacture *milk-sugar* and *casein* (which are not elsewhere found in the blood), and separate out *water*, *albumin*, and various *salts*. The *fats* of milk are, however, produced in a somewhat different manner. They are the result of a fatty metamorphosis of the cell-contents at the expense of which they are formed.

It was formerly supposed that the casein was derived from the cell-contents or protoplasm, and that it existed as a coat around the fat globules. This coat was called Ascherson's membrane.

Recent investigations, however, have proved that there is no caseous membrane around the fat globules, and that the casein occurs in milk in tiny jelly-like masses in combination with calcium oxide. (McConnell, Burnthsten, Fleishmann, Snyder, and others.)

The size of the *globules* of fat is a matter of some importance. It has been estimated that the largest globules found in cream are ·0005 in. in diameter, the smallest about one-tenth of this. The size of the globules, however, varies in different breeds, being largest in the Jerseys, and there is a gradual tendency towards diminution in size from about a month after calving onwards. The larger globules of course rise most rapidly as cream, and are most quickly churned, while milk containing small fat-globules is most suitable for cheese-making. Milk is an alkaline fluid, which readily becomes acid, and it has a specific gravity varying between 1,028 and 1,032, water being 1,000.

It is a typical food, because it contains all the necessary constituents for the nourishment and growth of the young animal.

In it the three great classes of food-stuffs are represented in the following way :—

1. The proteids, or nitrogenous compounds, by casein and albumin.

2. The carbohydrates, by milk-sugar (lactin), and galactose (lactose).

3. The fats, by the fat-globules, which consist of olein, stearin, palmitin, butyrin, caproin, and six other fats of less importance, and in small quantities.

Ordinary whole cow's milk should consist of thirteen, or not less than twelve, per cent. of solids.

An average composition is as follows :—

	Parts.
Water	87·0
Albuminoids (casein and albumin)	4·0
Carbohydrates (milk-sugar)	4·6
Fat	3·7
Ash (salts)	0·7
	100·0

The first milk after calving differs from ordinary milk in many important particulars.

This is called the *colostrum*, and it acts upon the young animal as an aperient.

It is a viscid yellowish-white fluid with an unpleasant taste, and a greater density than ordinary milk.

It is very rich in solids, and contains numerous ovoid bodies from the acini, called *colostrum corpuscles*, which have a tendency to adhere in small masses.

The following analysis of colostrum will show how it differs from ordinary milk :—

	Boussingault.
Water	75·8
Albuminoids	15·0
Fat	2·6
Milk-sugar	3·6
Ash	3·0
	100·0

The *colostrum disappears* on the third, fourth, or fifth day after calving, and the milk then becomes of the ordinary composition.

INTRALOBULAR.—Latin, *intra*, within. Within the lobules.

INTERLOBULAR.—Latin, *inter*, between. Between the lobules.

LYMPH.—Latin, *lympha*, water. The colourless fluid which fills the lymphatic, or absorbent vessels.

CAPILLARIES.—Latin, *capilla*, a hair.

CASEIN.—Latin, *caseus*, cheese.

PROTOPLASM.—Greek, *protos*, first; *plasma*, a formation (an elementary basis).

COLOSTRUM.—Latin *colostrum*, the first milk after delivery.

The albumin of ordinary milk does not usually exceed 0·54 per cent. of the whole.

The albumin of colostrum, and of milk towards the end of lactation, frequently reaches from 7 to 10 per cent. of the whole in amount.

Casein is one of the most interesting of the constituents of milk, as it is its chief proteid, and occurs in ordinary milk to the extent of about 3·04 per cent., or sometimes a little more.

It is very nearly allied to *legumin*, which is found in all plants, but to a large amount in peas and beans. A form of cheese, indeed, is made from peas in China, especially around Canton.

ALBUMIN.—Latin *albumen*, white of egg; from *albus*, white.
LEGUMIN.—Latin, *legumen*, pulse. The casein of plants.

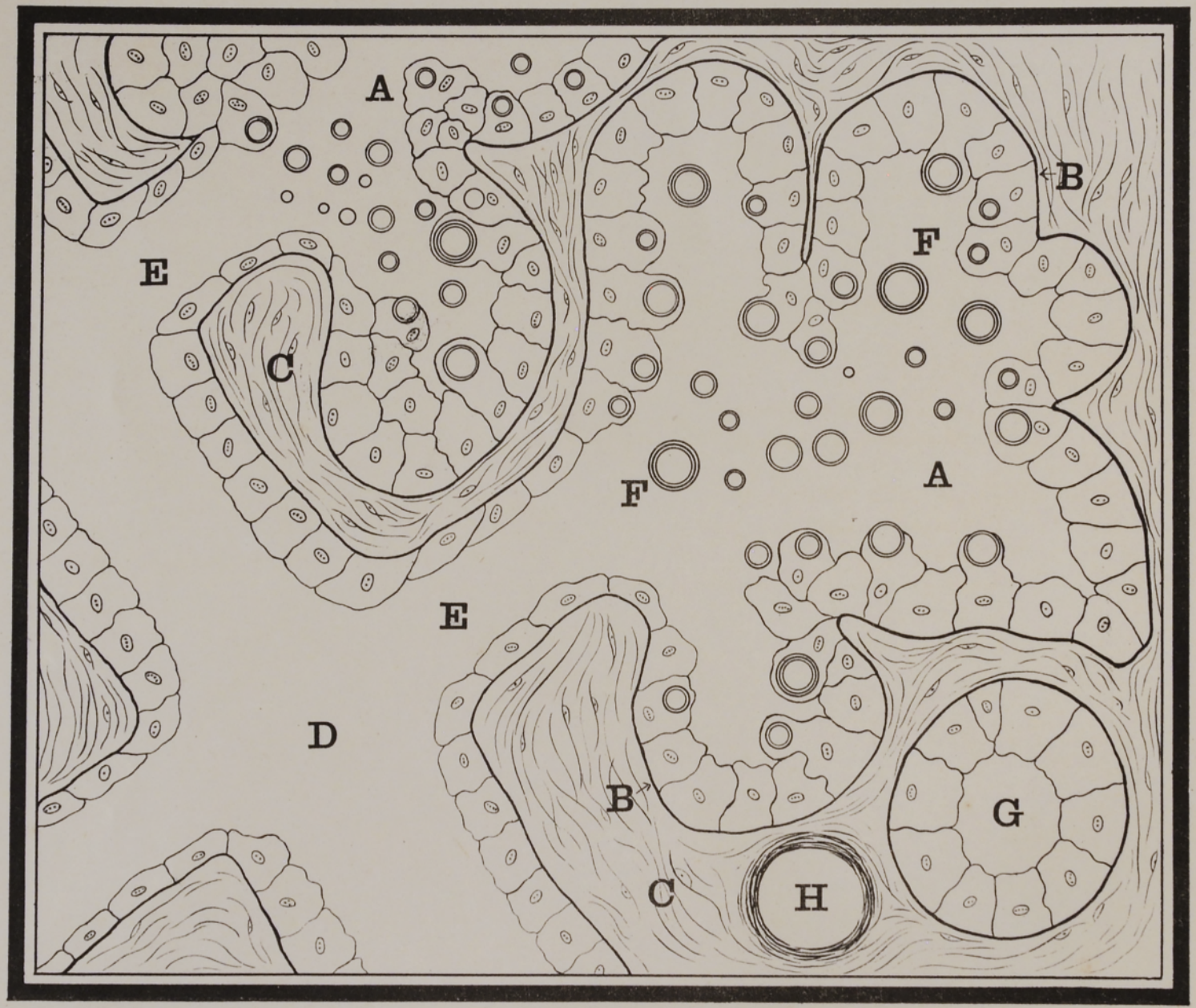
Casein is coagulated by rennet (as in the process of cheese-making), and also by the mineral acids, alcohol, and creosote.

It forms insoluble precipitates with such poisonous salts as acetate of lead, nitrate of silver, corrosive sublimate, &c., and hence the value of milk as an antidote in poisoning by these agents.

Casein is not coagulated by heat, and no precipitation occurs even at a temperature of 212° Fahr.

The salts contained in the ash of milk are numerous, and consist principally of phosphates, chloride, and citrate of potassium, chloride of sodium, phosphates of calcium and magnesium, with traces of fluoride of calcium, oxide of iron, and iodine. Oxide of calcium also is found in combination with casein.

RENNET.—Dutch, *rennen*, to curdle.



DIAGRAMMATIC SECTION
OF HIGHLY MAGNIFIED GLAND TISSUE.

[Drawn by H. C. Wilkie.

Entered at Stationers' Hall, 1903.]

DIAGRAMMATIC SECTION OF HIGHLY MAGNIFIED GLAND TISSUE.

AA. Acini seen in cross-section.

BB. Basement membrane supporting the epithelial or lining cells of the acini.

C. Interstitial connective tissue.

D. Interlobular duct.

EE. Intralobular duct.

FF. Fat-globules (many of which can be seen still within the cells).

G. Duct cut across.

H. Blood-vessel.

INTERSTITIAL.—Latin *interstitium*, space between—*inter*, between ; *sisto*, I stand.

FIG. 3. SECTION OF ONE HALF OF THE UDDER OF THE EWE.

This drawing shows a section through one lateral half of the udder of the ewe, exposing the main trunks of its *blood-vessels*, its *lymphatic glands*, its large *galactophorous sinus*, and the long pointed *teat* characteristic of ovine animals.

The udder of the ewe consists of *two lateral halves*, each of which is a distinct gland in itself, being separated from that of the other side by two layers of the fibrous tunic D and F, which are continuations of the tunic covering the whole of each gland or half of the udder. The broad suspensory bands are similar to those of the cow.

The skin which covers the organ is white (or flesh-coloured), and a deep median furrow marks the limits of the two glands.

The glandular tissue is practically identical with that of the cow, and the nutrient arterial blood is conveyed in a similar way by the *external pudic artery*, which is a fair-sized vessel.

The veins are of two kinds, *superficial* and *deep*.

The *subcutaneous abdominal vein* is, like that of the cow, made up of a large number of anastomosing vessels, but it is not relatively so large as in that animal.

The *deep veins* are small, but numerous, and unite to form the external pudic vein.

The *lymphatic glands* (C) lie in a mass of fat behind the *external inguinal* ring.

They consist of *two*, or sometimes more, moderate-sized kidney-shaped glands to each lateral half of the udder, and they receive the *afferent* lymphatic vessels from the glandular tissue, the *efferents* passing with the blood-vessels and nerve through the *inguinal* canal.

The *galactophorous* sinus in the ewe is large, and somewhat similar in construction to that of the cow, but the pillars around the openings of the *lactiferous ducts* are more prominent, and these openings are relatively larger.

The lining-membrane of the teat shows no tranverse *rugæ*, as in the cow, but its small folds take a longitudinal direction.

The *mammilla*, or teat, of the ewe has several characteristic features.

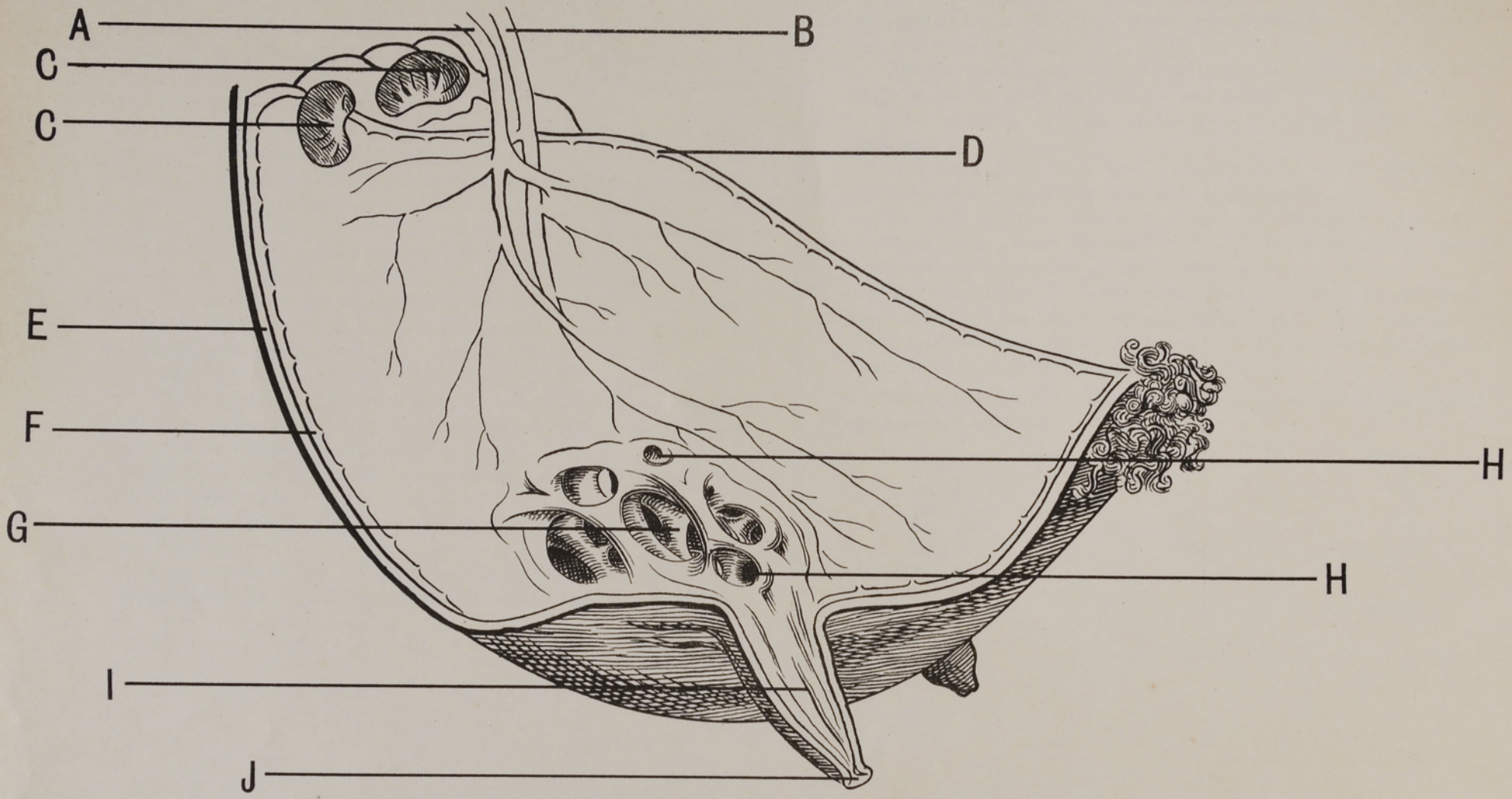
It is long, thin, and pointed, laterally placed on the udder, and projects considerably forwards as well as downwards.

Its walls are thin, and it has a distinct *sphincter* of circular muscular fibres around the single orifice of its free extremity, which is marked with a *peculiar lip-like prominence* (J).

The milk of the ewe is very rich in *fat* and *albuminoids*, and shows total solids to the extent of *nineteen per cent*. It is capable of making an excellent cheese, as is seen in the production of rubiole, which is made in Italy from the milk of ewes.

The following is about an average analysis of the composition of normal ewe's milk :—

	Doyére.
Water	81·60
Casein	4·00
Albumin	1·70
Fat	7·50
Sugar	4·30
Ash	0·90
	100·00



SECTION OF ONE HALF OF THE UDDER OF THE EWE.

[Drawn by H. C. Wilkie.

Entered at Stationers' Hall, 1903.]

SECTION OF ONE HALF OF THE UDDER OF THE EWE.

A. The mammary artery.
B. The mammary vein.
CC. Lymphatic glands.
D. Fibrous tunic in contact with that of the abdominal wall.
E. Skin.
F. Fibrous covering or tunic.
G. Galactophorous sinus.
HH. Openings of lactiferous ducts.
I. Lining-membrane of the teat.
J. External orifice of the teat.

FIG. 4. SECTION OF ONE HALF OF THE UDDER OF THE MARE.

THIS drawing shows a section through one lateral half of the udder of the mare, with its teat, and exhibits the characteristic shape of the gland, the larger trunks of the blood-vessels, the lymphatic glands, *galactophorous sinuses*, with the entrances of the *lactiferous ducts*, and the passages through the teat to the external orifices.

The udder of the mare consists of two lateral halves, separated by a narrow furrow, each half being provided with a single teat.

The skin which covers the organ is black in colour, thin, smooth, and greasy, being supplied with numerous large *sebaceous* glands.

The *glandular tissue* is of the same general construction as that of the cow's udder, being composed of *acini*, with their secreting cells, surrounded by networks of *capillary* vessels and *lymph-spaces*, the whole supported by strong elastic connective tissue.

The *galactophorous sinuses* in the mare differ very considerably from those of the cow, as there are always two, sometimes even *three or four*, opening into the teat, which has two or more external orifices.

The sinuses, however, are small in capacity, and exhibit a limited number of somewhat large openings, which are the general confluents of a considerable number of *lactiferous ducts* (H).

The *mammary artery* is from the external pudic as in the cow, but the nerves are from the *first lumbar pair*.

The veins are very numerous, and are divided into *superficial* and *deep*.

The *subcutaneous abdominal* or, as it is often here called, the *posterior abdominal* vein is of small capacity, and does not bear any comparison with that of the cow, while the deep veins are very similar to those of the latter animal, as they are of considerable size, and unite to form the external pudic vein.

The *lymphatic glands*, situated immediately behind the blood-vessels and nerves, as they pass through the *external inguinal ring* to the *inguinal canal*, consist of a cluster of numerous small round bodies as seen at C. Their *afferent* and *efferent* vessels are collectively very similar in number and origin to those described as passing to and from the glands in the cow's udder.

The *mammillæ*, or teats, two in number, are short, blunt, and flattened from side to side; they are covered with very smooth, thin, black skin, and usually have three or four orifices each at the free extremity.

In many cases, however, only two of these are perforate, and this is the most usual number from which to obtain milk in the mare.

Around the walls of the teat are found numerous bundles of both circular and longitudinal muscular fibres, the circular fibres forming sphincters around the orifices.

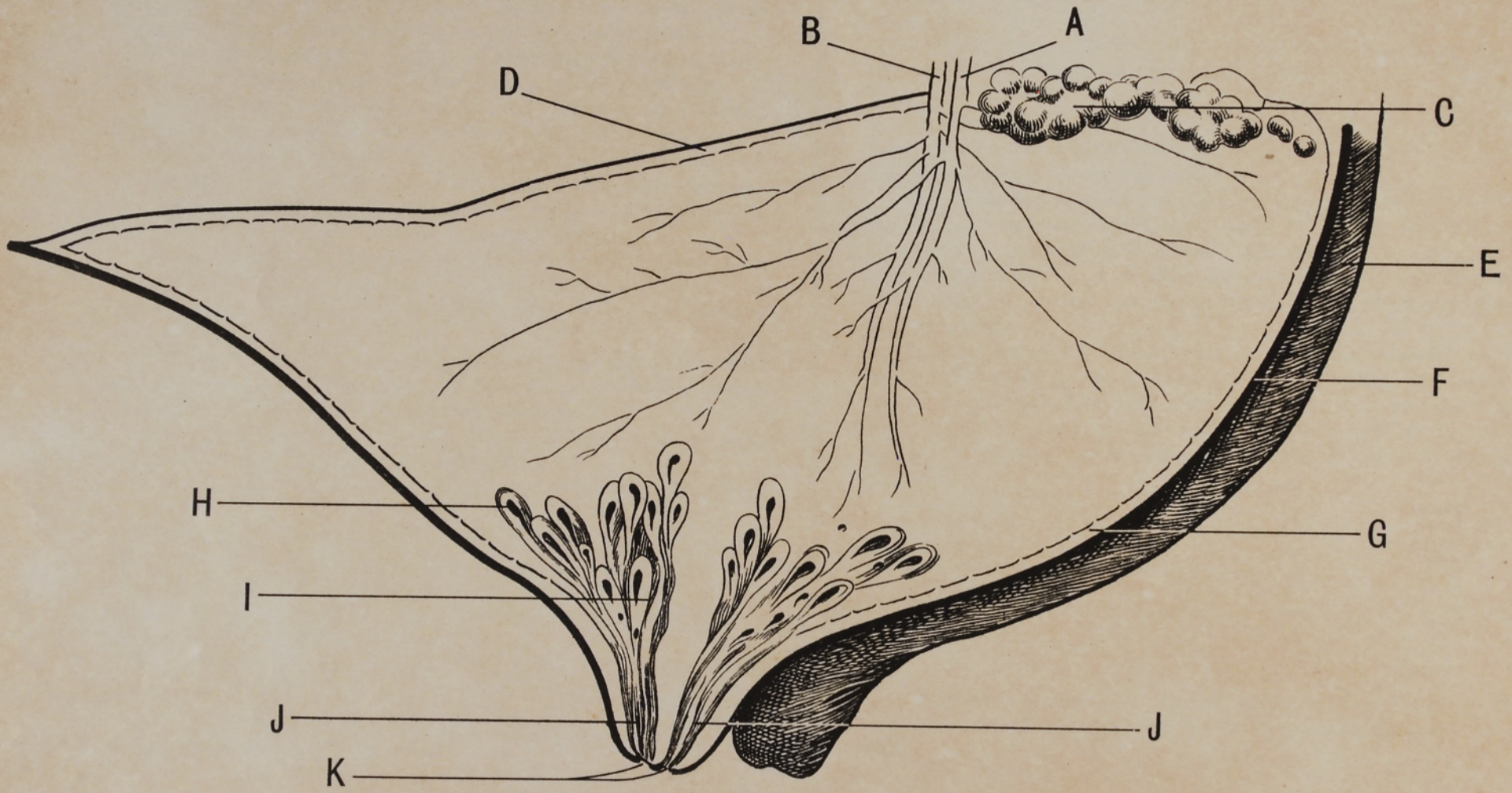
The lining-membrane of the passages in the teat does not show any *rugæ*, or transverse wrinkles as in the cow, but its few folds are disposed in a longitudinal direction. The milk of the mare, as in most of the herbivora, is *alkaline*, and it is the most easily digested of all milks, which fact has an important bearing on the artificial rearing of foals.

A foster-mother for a foal is not always easily obtained, as so many mares refuse to allow a strange foal to suck. In rearing a foal by hand, where only cow's milk is available, it is necessary that this should be made to approach as nearly as possible the composition of normal mare's milk, which may be stated as the following:—

	Snyder.
Water	88·49
Casein	3·00
Albumin	0·35
Sugar	4·75
Fat	2·86
Ash	0·55
	100·00

Colostrum, a necessity for the calf, is even a greater one for the foal, whose bowels are still more apt to require a gentle purgative at birth.

SEBACEOUS.—Latin, *sebum*, any fatty matter. Sebaceous glands secrete an oily matter for the lubrication of the hairs and skin.



SECTION OF
ONE HALF OF THE UDDER OF THE MARE.

[Drawn by H. C. Wilkie.

SECTION OF ONE HALF OF THE UDDER OF THE MARE.

A. The mammary artery.

B. The mammary vein.

C. Lymphatic glands.

D. Fibrous tunic of the mammary glands which is in contact with that of the abdomen.

E. The external aspect of the other lateral half of the mammary gland.

F. Skin.

G. Fibrous tunic.

H. Openings of lactiferous ducts.

I. The galactophorous sinus.

JJ. The internal passages in the teat, showing the longitudinal folds of its lining-membrane.

K. Two orifices at the free extremity of the teat.

By Authority: JOHN MACKAY, Government Printer, Wellington.—1904.

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