Vet eBooks
VET-EBOOKS.COM

FREE · NO SIGN-UP

ANATOMY · RUMINANT · ILLUSTRATED GUIDE

RUMINANT STOMACH ANATOMY

Ruminant Stomach Anatomy: The Four Stomachs of a Cow (PDF)

The four stomachs — rumen, reticulum, omasum and abomasum — their sacs, pillars and grooves, the topography of the live animal, and the diseases the anatomy explains. Companion to the article at vet-ebooks.com.

Contents

The 11 sections of this guide, in order.

IN SHORT

Ruminant stomach anatomy is usually taught as "four stomachs", but it is really *one* stomach with four compartments — and only the last of them is a true, acid-secreting stomach. The **rumen**, **reticulum** and **omasum** are non-glandular forestomachs that ferment, sort and dehydrate; the **abomasum** is the glandular stomach proper. This guide walks each compartment with labelled dissection plates, sets out the pillars and sacs of the rumen, explains the **reticular groove**, and then turns the anatomy into the conditions you will actually meet — bloat, hardware disease and the displaced abomasum. A free illustrated PDF is included.

KEY POINTS

1. It is **one stomach with four compartments**, not four stomachs. Three are **non-glandular forestomachs** (rumen, reticulum, omasum); only the **abomasum** secretes acid.
2. The **rumen** is about **80%** of the whole stomach and fills virtually the entire left half of the abdomen — which is why you auscultate the **left paralumbar fossa**.
3. The rumen is divided by muscular **pillars** into dorsal, ventral and cranial sacs plus two **caudal blind sacs**. Gas collects dorsally, fibre (fiber) floats in the middle, fluid sits ventrally.
4. The **reticulum** is the most **cranial and ventral** compartment, lying against the diaphragm opposite the heart — the anatomical reason for **hardware disease**.
5. The **reticular groove** closes in the suckling calf so **milk bypasses the forestomachs** and goes straight to the abomasum.
6. The **abomasum** normally lies on the floor of the abdomen mostly to the **right**; gas can float it **left (LDA)** or right, where it may twist.

About the images

Dissection photographs and schematics are reproduced for educational reference from *Guide to Ruminant Anatomy: Dissection and Clinical Aspects* (2nd ed., Wiley), and the atlas plates from *Bovine Anatomy: An Illustrated Text* (Budras KD et al., 2nd ext. ed.). Each figure is credited beneath it; copyright remains with the original authors and publishers.

This illustrated guide to **ruminant stomach anatomy** works through the **four stomachs of a cow** one compartment at a time — the rumen, reticulum, omasum and abomasum — with labelled dissection plates, the internal landmarks you are expected to name, and the clinical conditions each one explains. It is written for veterinary students and for clinicians working with cattle, sheep and goats, and it pairs with our whole-body Cattle Anatomy guide.

01 One stomach, four compartments

The first thing to correct is the phrase itself. A ruminant does not have four stomachs; it has **one compartmentalised stomach**. All four chambers develop from a single **gastric spindle** in the embryo — they are not oesophageal in origin — but the first three end up lined by **non-glandular stratified squamous epithelium**, while only the fourth becomes the true glandular stomach. Everything else follows from that: the forestomachs cannot secrete acid or enzymes, so digestion there is entirely **microbial**.

COMPARTMENT	SHARE OF STOMACH*	LINING	WHAT IT DOES
1. Rumen (paunch)	~80%	**Non-glandular** stratified squamous, covered in **papillae**	The fermentation vat. Houses the microbial population, absorbs volatile fatty acids through the papillae, and mixes by powerful contractions
2. Reticulum (honeycomb)	~5%	**Non-glandular**, raised into a **honeycomb** of reticular crests and cells	Sorts particles: its biphasic contraction *starts* each motility cycle — though the pattern is generated centrally, in the medulla, and delivered by the vagus — driving fine material into the omasum and coarse material back for more chewing. Traps swallowed metal — hence **hardware disease**
3. Omasum (bible / manyplies)	~7–8%	**Non-glandular**, folded into stacked **laminae** like the pages of a book	Squeezes ingesta between the laminae and absorbs water, sodium and residual volatile fatty acids
4. Abomasum (true stomach)	~7–8%	**Glandular** — cardiac, fundic and pyloric glands	The **true stomach**. Secretes hydrochloric acid, pepsinogen and, in the young, rennin. The only compartment homologous with the simple stomach of a dog or horse

* Approximate proportions of total stomach capacity in the adult ox. The values shift dramatically with age — see From calf to cow.

02 The shape of the whole stomach

Before dissecting the compartments individually it helps to see the whole organ. From the **left** the rumen dominates completely: a large ovoid mass marked by the **longitudinal, cranial and caudal grooves** (the coronary grooves show on the sectioned and right-side views), with the small reticulum tucked in front and the fundus of the abomasum just visible below.

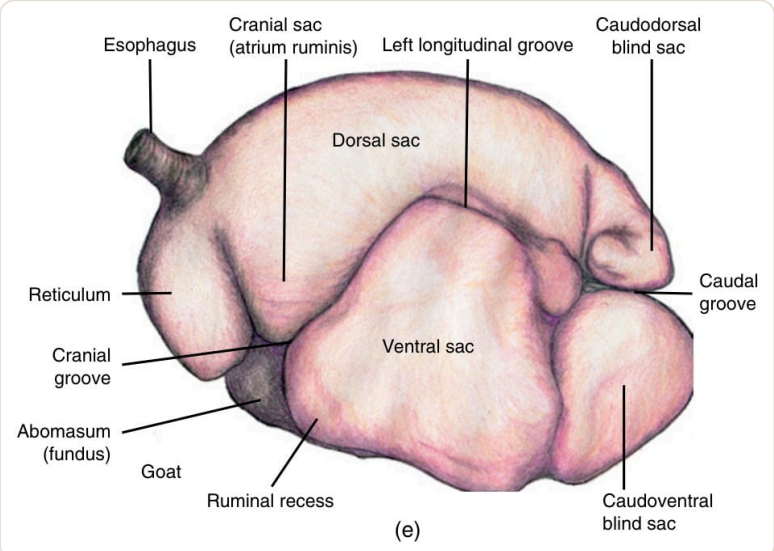

Fig 1 — The stomach from the left. The external grooves mark the internal pillars. The **dorsal** and **ventral sacs** are separated by the left longitudinal groove; the **cranial sac (atrium ruminis)** lies at the front next to the **reticulum**, and the two **caudal blind sacs** lie behind. Only the fundus of the abomasum appears on this side.

Image — Sarhan MS, Reece WO et al. Guide to Ruminant Anatomy: Dissection and Clinical Aspects , 2nd ed. Wiley — Fig 3.18e, goat stomach, left surface. Reproduced for educational reference.

Turn the organ over and the picture changes entirely: from the **right** you meet the **omasum** — a firm, rounded ball — and the **abomasum** curving away from it toward the duodenum. This is the side the clinician cares about when an abomasum displaces.

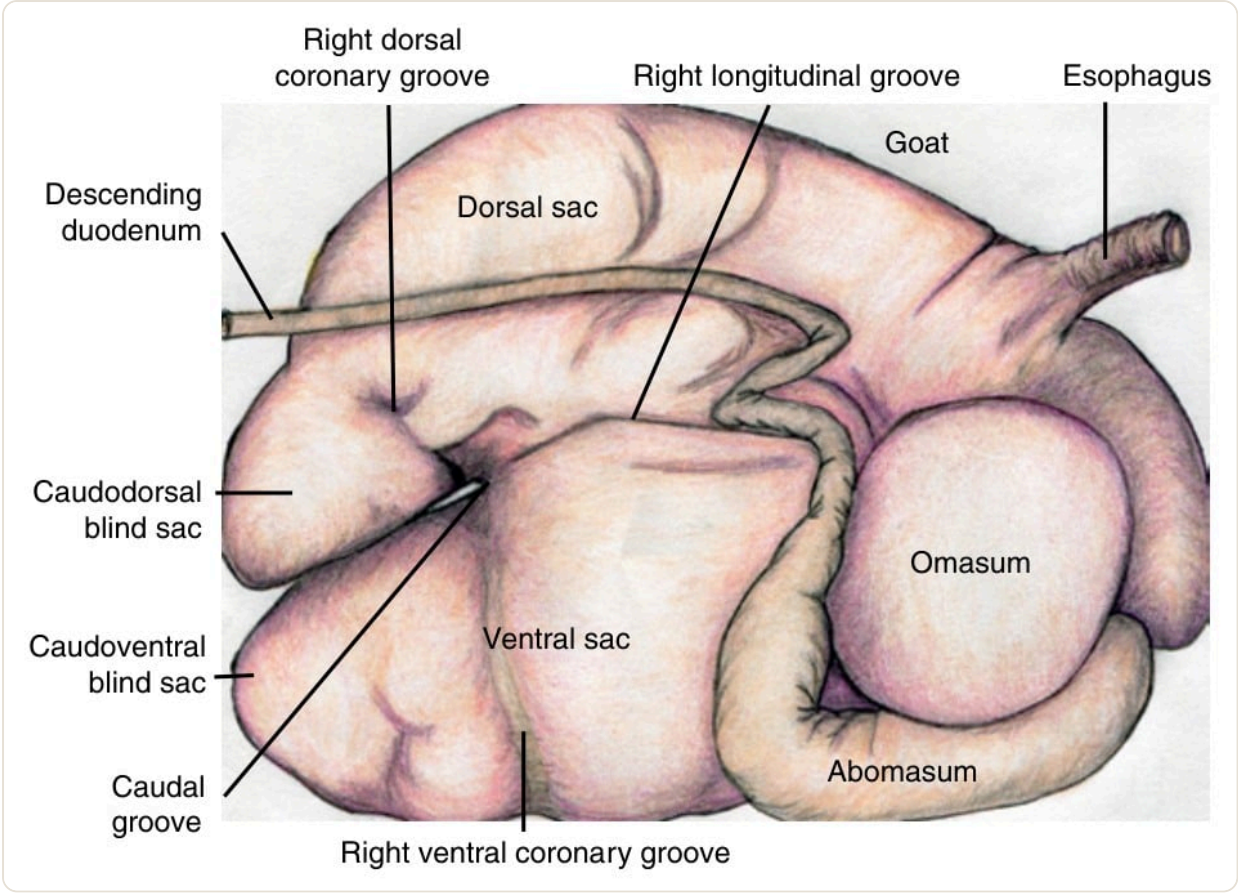

Fig 2 — The stomach from the right. The same organ reversed. The globular **omasum** and the curved **abomasum** occupy the right surface, with the **descending duodenum** running away caudally, toward the pelvis. Note how the abomasum wraps from the omasum around the ventral sac — the route it takes when it displaces.

Image — Sarhan MS, Reece WO et al. Guide to Ruminant Anatomy: Dissection and Clinical Aspects , 2nd ed. Wiley — Fig 3.18f, goat stomach, right surface. Reproduced for educational reference.

The classic atlas plate below puts all of it together — both surfaces, plus both surfaces in section — with a full numbered legend. It is worth studying slowly; almost every term in this article appears on it.

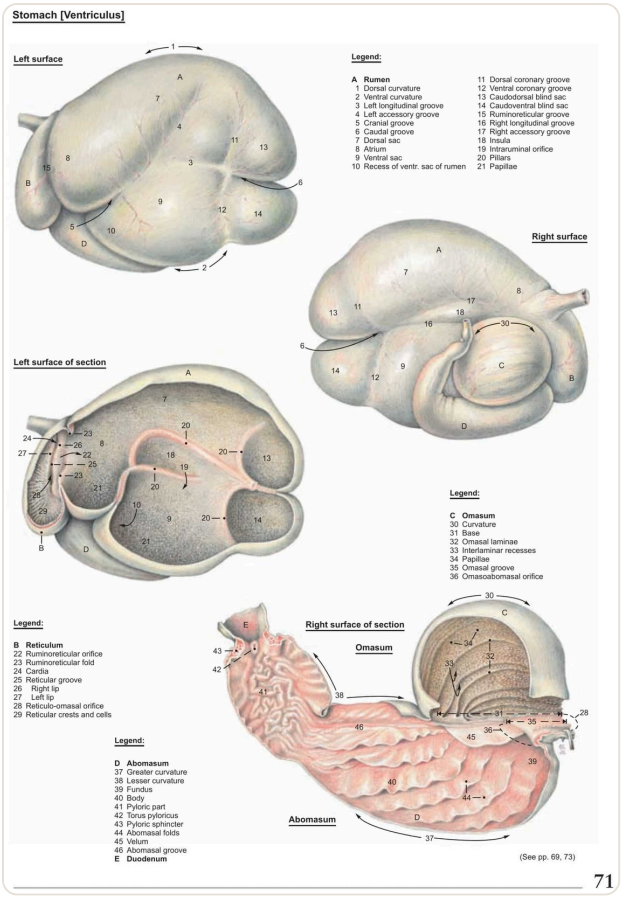

Fig 3 — The complete stomach, four views. Left surface, right surface, and both surfaces in section, with legends for the **rumen (A)**, **reticulum (B)**, **omasum (C)** and **abomasum (D)**. The sectioned views reveal the pillars, the reticular crests and cells, the omasal laminae and the abomasal folds.

Image — Budras KD, Habel RE, Mülling CKW, Greenough PR. Bovine Anatomy: An Illustrated Text , 2nd ext. ed. Schlütersche — Stomach [Ventriculus], p. 71. Reproduced for educational reference.

03 The rumen: sacs, pillars and the fermentation vat

The rumen is a fermentation chamber of extraordinary size — estimates of its capacity in an adult cow vary widely with body size and with who is measuring — Budras gives roughly **100–150 litres** for the rumen alone, while Dyce puts it nearer 60 — and it occupies almost the entire left half of the abdomen, from diaphragm to pelvis. Its wall is thrown into thick muscular ridges called **pillars** which project inward and divide the lumen into communicating sacs.

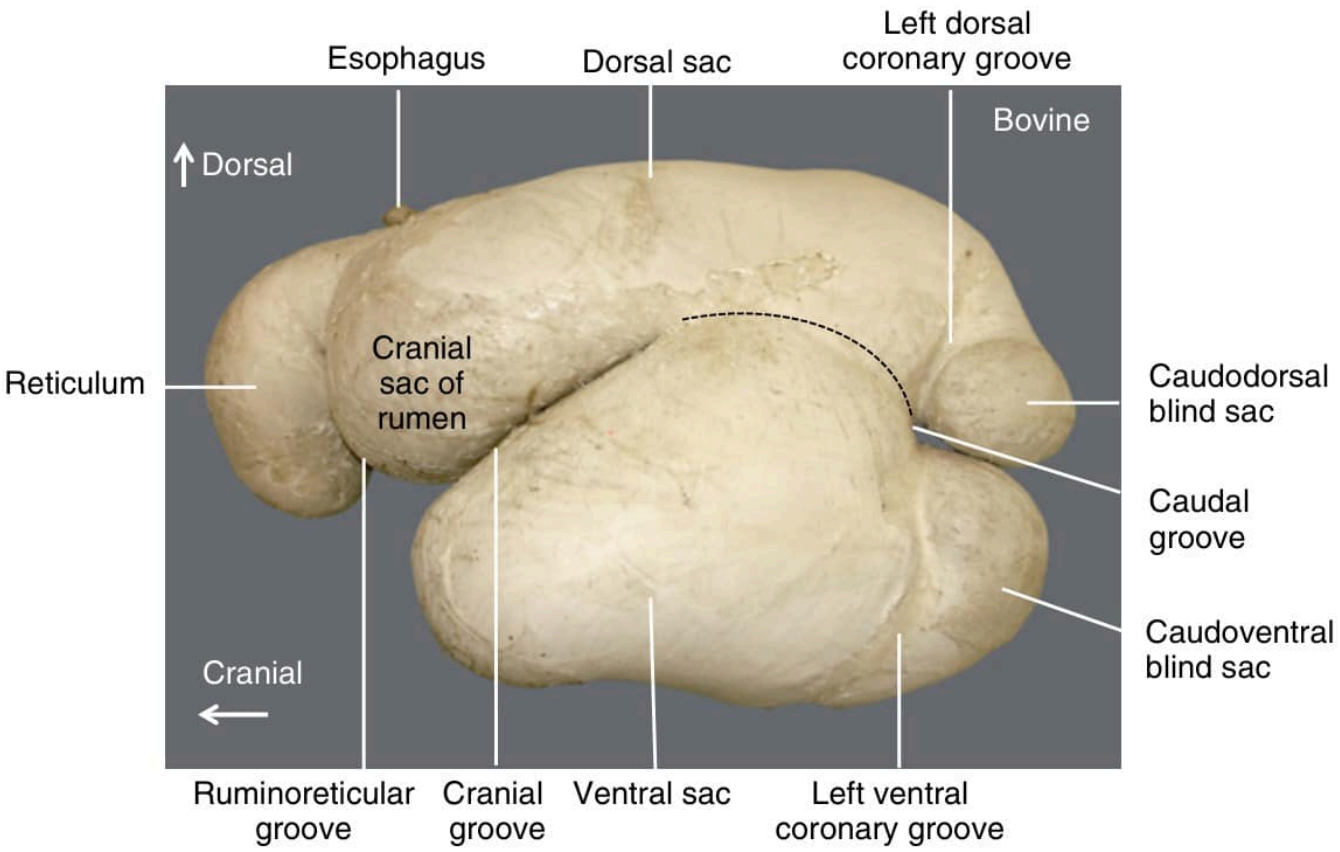

Fig 4 — The ruminoreticular compartment, left lateral view. The isolated organ: **reticulum** in front, then the **cranial sac**, the large **dorsal** and **ventral sacs**, and the **caudodorsal** and **caudoventral blind sacs** behind. The external grooves — ruminoreticular, cranial, longitudinal, coronary and caudal — correspond exactly to the internal pillars.

Image — Sarhan MS, Reece WO et al. Guide to Ruminant Anatomy: Dissection and Clinical Aspects , 2nd ed. Wiley — Fig 3.18a, bovine ruminoreticular compartment. Reproduced for educational reference.

Open the rumen and the pillars become obvious. They are not passive partitions: they are muscular, they contract in a coordinated sequence, and they are what churns that vat of fibrous soup one to three times a minute.

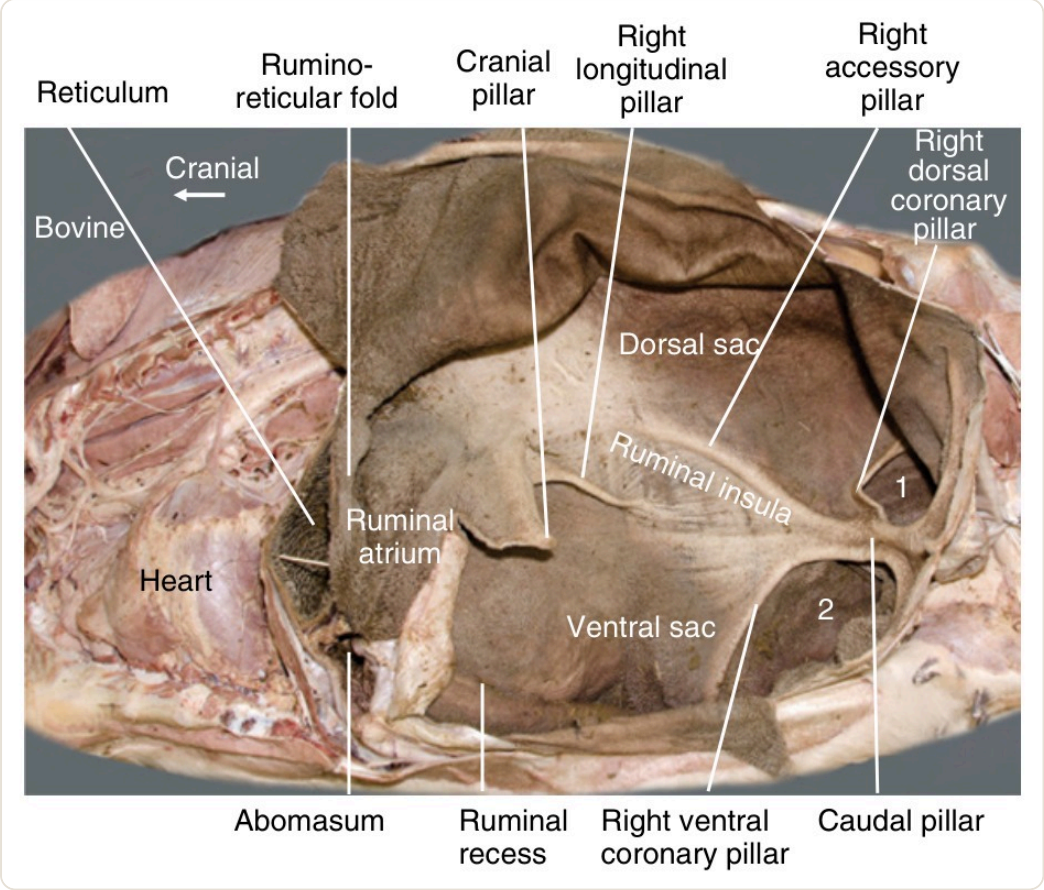

Fig 5 — The rumen opened in situ. Looking at the right interior wall. The **cranial**, **right longitudinal**, **right accessory**, **caudal** and **coronary pillars** stand out as pale muscular ridges, with the **ruminal insula** between them and the two blind sacs (1, 2) behind. The **ruminal atrium** and **ruminoreticular fold** are at the front; note how close the **heart** and **abomasum** lie.

Image — Sarhan MS, Reece WO et al. Guide to Ruminant Anatomy: Dissection and Clinical Aspects , 2nd ed. Wiley — Fig 3.19a, bovine rumen opened in situ. Reproduced for educational reference.

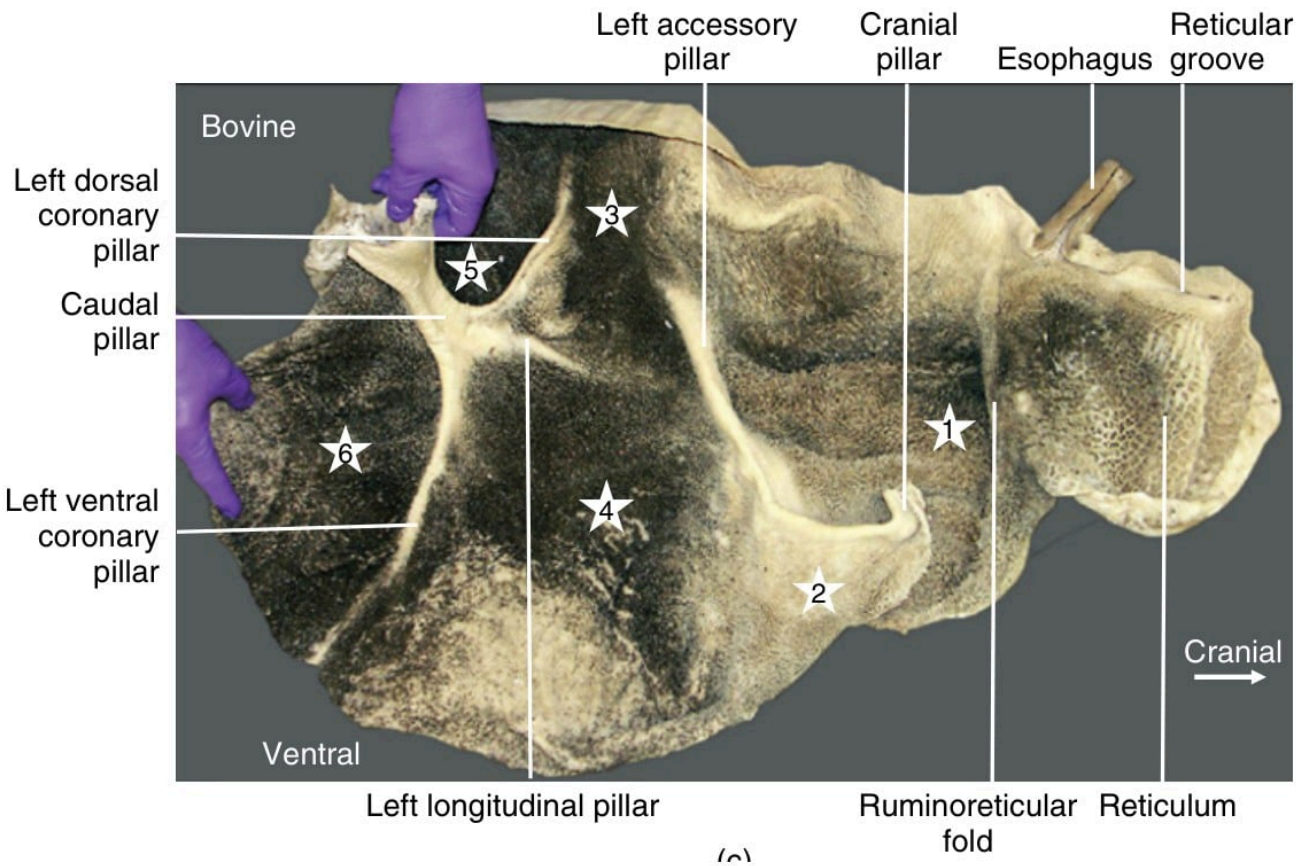

Fig 6 — The opened rumen, left interior wall. The mirror view of the previous figure. The **left longitudinal**, **left accessory**, **cranial**, **caudal** and **left coronary pillars** divide the lumen; the stars mark the chambers — 1 ruminal atrium, 2 ruminal recess, 3 dorsal sac, 4 ventral sac, 5 caudodorsal and 6 caudoventral blind sacs. The **reticulum** with its honeycomb lining and the **reticular groove** are at the right of the picture.

Image — Sarhan MS, Reece WO et al. Guide to Ruminant Anatomy: Dissection and Clinical Aspects , 2nd ed. Wiley — Fig 3.19c, opened bovine rumen, left sagittal view. Reproduced for educational reference.

LANDMARK	WHERE IT IS	WHY IT MATTERS
Dorsal & ventral sacs	The two main chambers of the rumen, separated by the **right and left longitudinal pillars**	The dorsal sac holds the fermentation gas cap; the ventral sac holds the heavier fibre mat and fluid
Cranial sac (atrium ruminis)	At the front, continuous with the reticulum over the **ruminoreticular fold**	Where the oesophagus (cardia) delivers, and where gas is belched from
Caudodorsal & caudoventral blind sacs	The two rounded caudal ends, separated by the **caudal pillar** and bounded by the **coronary pillars**	The caudodorsal blind sac is the part that tympanises first in **bloat**
Pillars (longitudinal, cranial, caudal, coronary, accessory)	Thick muscular ridges of the wall projecting into the lumen	They are the internal skeleton of the rumen: they define the sacs and generate the mixing contractions
Ruminal insula	The island of wall between the right longitudinal and accessory pillars	A useful orientation landmark on the opened right wall
Reticular groove (oesophageal groove)	Runs from the cardia down the wall of the reticulum to the reticulo-omasal orifice	In the suckling calf its lips close to form a tube, so **milk bypasses the forestomachs** and goes straight to the abomasum

The schematic sagittal view is the single most useful image to fix in your memory, because it shows every named sac and pillar in one plane and makes the sequence from oesophagus to reticulo-omasal orifice obvious.

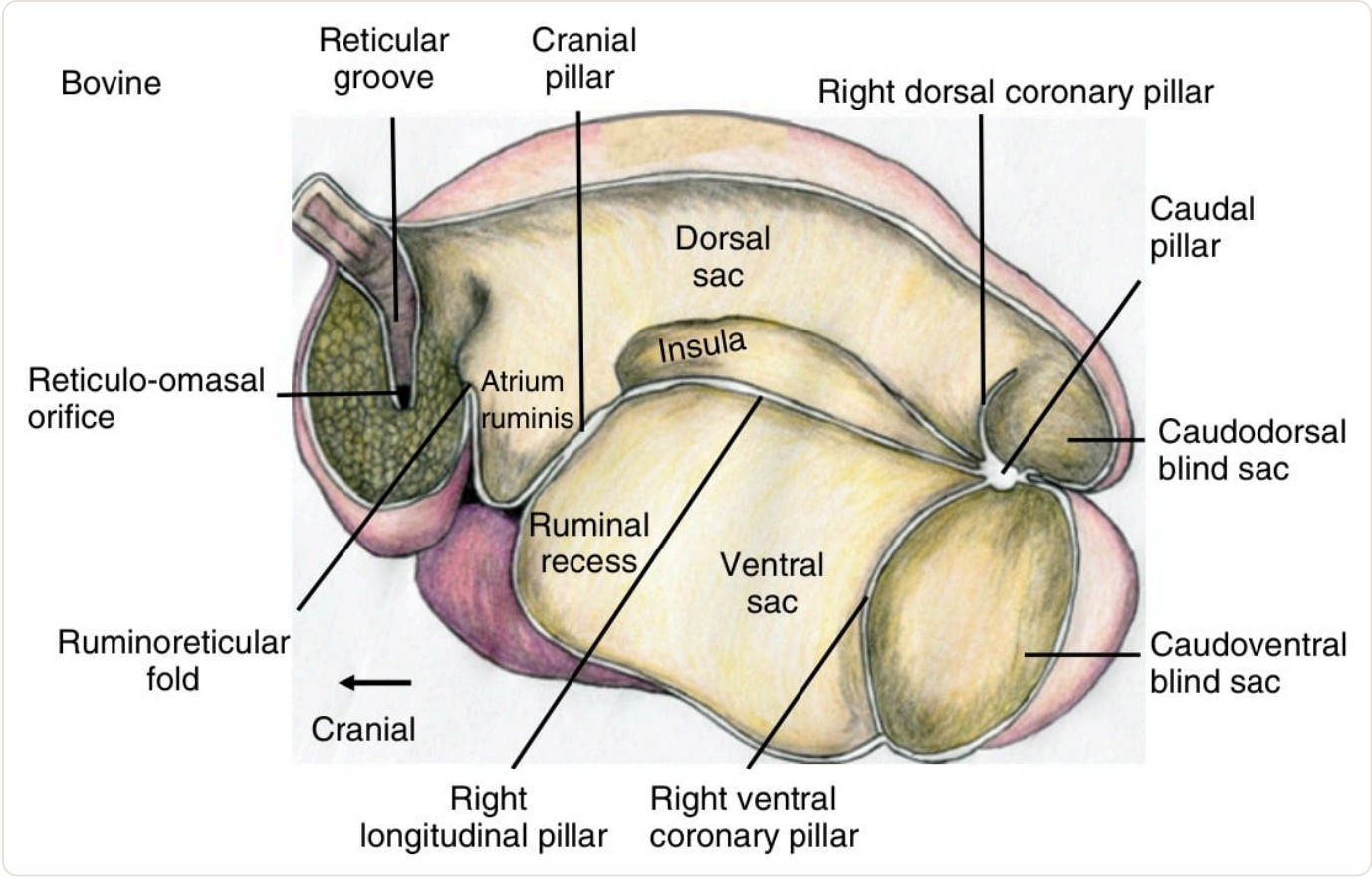

Fig 7 — The stomach in sagittal section. The reference drawing: **reticular groove** running from the cardia to the **reticulo-omasal orifice**; the **atrium ruminis**; the **cranial**, **caudal**, **longitudinal** and **coronary pillars** outlining the **dorsal** and **ventral sacs**, the **ruminal recess**, the **insula**, and the **caudodorsal** and **caudoventral blind sacs**.

Image — Sarhan MS, Reece WO et al. Guide to Ruminant Anatomy: Dissection and Clinical Aspects , 2nd ed. Wiley — Fig 3.19b, bovine stomach, left sagittal view. Reproduced for educational reference.

Functionally the contents stratify: a **gas cap** in the dorsal sac, a floating **fibre mat** below it, and a **fluid layer** with the finest particles at the bottom of the ventral sac. That layering is why gas is belched from the top, why coarse fibre is regurgitated for re-chewing, and why only the fine, dense material at the bottom moves on. The mucosa itself is covered with **papillae** — finger-like projections that hugely increase the surface for absorbing the volatile fatty acids that are the animal's main energy source. All three forestomachs are lined by **keratinised stratified squamous epithelium** with no glands and no goblet cells — and note that the papillae are **absent over the pillars**, which is a reliable way to identify a pillar on a histology slide.

Inside the fermentation vat: microbes, VFAs and pH

Every millilitre of rumen fluid holds on the order of **ten billion bacteria**, alongside ciliate protozoa, anaerobic fungi and methanogenic archaea. Between them they ferment cellulose and hemicellulose — which no mammalian enzyme can touch — into the three **volatile fatty acids** the animal actually lives on: **acetate**, **propionate** and **butyrate**. These supply the large majority of the ruminant's metabolisable energy and are absorbed directly across the ruminal papillae, which is why papillary surface area matters so much. Acetate is the precursor of milk fat; **propionate** is the main substrate for glucose production in the liver, and it is the shortfall of propionate in negative energy balance that pushes a fresh cow into **ketosis**.

Saliva, ruminal pH and why buffering matters

A dairy cow produces well over a hundred litres of **saliva** a day, and it is not there to wet the feed: it is a **bicarbonate and phosphate buffer** that neutralises the acid the microbes generate. Long fibre drives chewing, chewing drives salivation, and salivation holds ruminal pH in roughly the **6.0–7.0** band that fibre-digesting microbes need. Replace effective fibre with rapidly fermented starch and both halves of that equation fail at once — more acid produced, less buffer delivered — which is the whole mechanism of **subacute ruminal acidosis (SARA)**, and the reason a cow chewing the **cud** is a healthy cow.

04 The reticulum and the reticular groove

The reticulum is small but disproportionately important. It sits **furthest forward and lowest** of all the compartments, pressed against the diaphragm at roughly the level of the **sixth to eighth ribs** — with the heart immediately in front of it. Its lumen is continuous with the rumen over the **ruminoreticular fold**, which is why the two are treated as one functional **ruminoreticular compartment**.

Its lining is unmistakable: raised crests dividing the surface into four- to six-sided cells, giving the **honeycomb** appearance that names it.

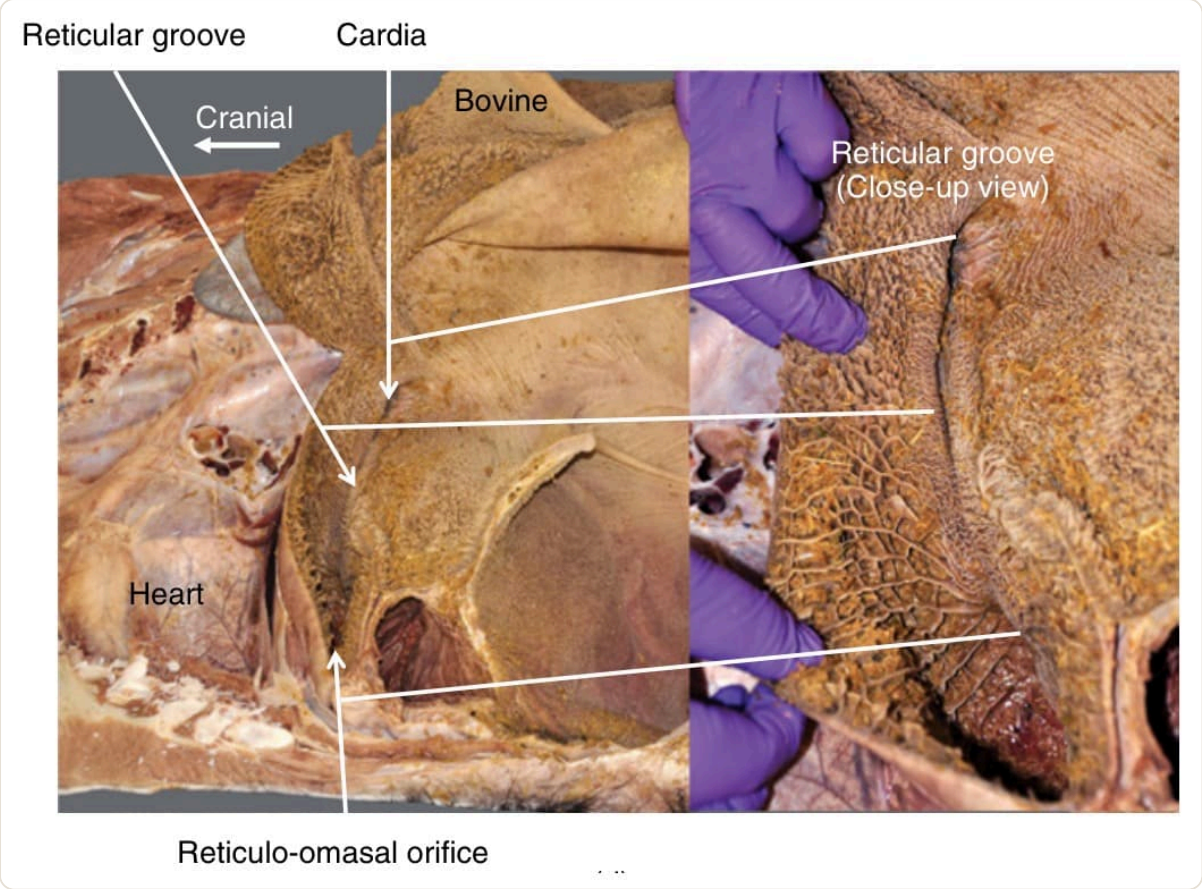

Fig 8 — The reticulum, cardia and reticular groove. Left, the interior in situ with the **cardia** above and the **reticulo-omasal orifice** below, joined by the **reticular groove**. Right, the close-up: the **honeycomb** of reticular crests and cells, and the muscular lips of the groove itself.

Image — Sarhan MS, Reece WO et al. Guide to Ruminant Anatomy: Dissection and Clinical Aspects , 2nd ed. Wiley — Fig 3.19d, reticular groove, with close-up. Reproduced for educational reference.

The **reticular groove** (older texts call it the oesophageal groove) runs from the **cardia** down the right wall of the reticulum to the **reticulo-omasal orifice**. In the suckling calf, the act of nursing triggers a reflex that makes the two muscular lips of the groove roll together into a closed tube, so **milk bypasses the rumen and reticulum**, running down the groove into the omasal canal and dropping straight into the abomasum where it can be clotted and digested. (A small fraction — around a tenth or less — still spills into the rumen.) The groove is the first part of a longer channel — the **gastric groove** — formed by the reticular, omasal and abomasal grooves in sequence.

Why this matters at the drench gun.

The reflex is why milk-fed calves thrive, and why oral fluids given to an older ruminant end up in the rumen rather than the abomasum unless the groove is deliberately stimulated. It is also why a ruminating animal cannot simply be treated like a monogastric when you dose it orally. And the reflex can *fail*: in **ruminal drinking**, milk that should have gone down the groove spills into the small, undeveloped rumen and ferments there, producing a poorly grown, pot-bellied calf with chronic pasty diarrhoea (diarrhea) — a consequence of cold, fast or bucket feeding, or any illness that blunts the reflex.

Because the reticulum is the most cranioventral compartment and contracts vigorously, any dense foreign body a cow swallows — wire, nails — drops into it and gets driven forward. That is the whole of **hardware disease** in one sentence of anatomy.

05 The omasum: the pages of the book

The omasum is a firm, almost spherical organ lying on the **right** of midline. Cut it open and the reason for its nicknames — *bible*, *manyplies*, *book stomach* — is immediately clear: the interior is filled with about **a hundred laminae** in four orders of size, stacked like the leaves of a book and studded with small papillae.

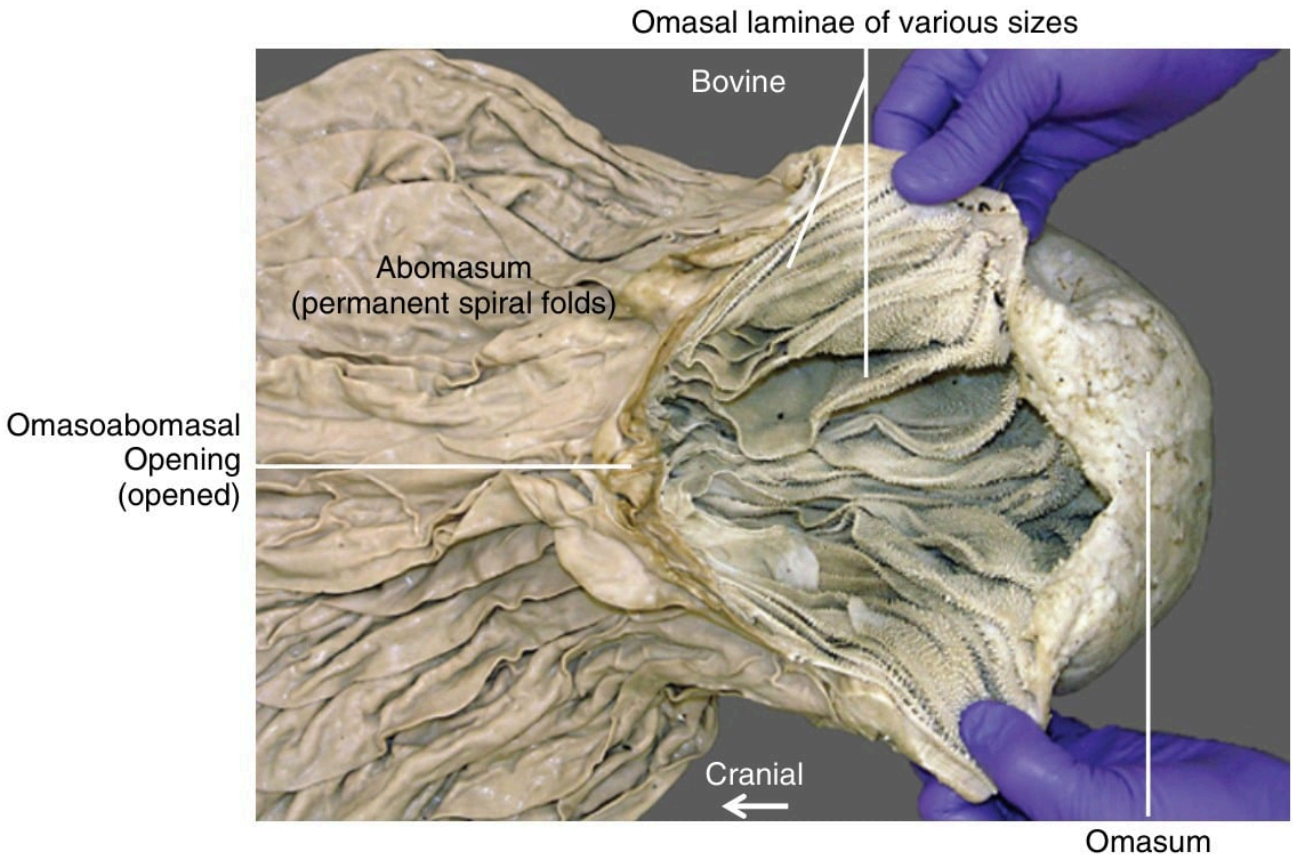

Fig 9 — The omasum and abomasum opened. Cut along the lesser curvature. On the right the **omasal laminae of various sizes** stack like pages; on the left the **abomasum** with its **permanent spiral folds**. Between them lies the **omasoabomasal opening**, guarded by two folds known as the *vela abomasica*.

Ingesta arriving from the reticulum is squeezed between these laminae, which press out and absorb a large volume of **water** along with residual volatile fatty acids. The shallow, lamina-free channel running along the lesser curvature between the reticulo-omasal orifice and the omasoabomasal orifice is the **omasal groove**.

What the omasum actually does

A large share of the water arriving from the reticulum is removed here, along with a useful part of the residual volatile fatty acids — the laminae give it an absorptive surface out of all proportion to its size. They are graded into several orders: the largest run the full depth of the organ, the smallest fill the spaces between, and all are studded with short papillae. The muscular squeeze between them also completes the particle reduction begun by rumination, so what reaches the abomasum is a fine, comparatively dry paste. An omasum that stops emptying — most often in vagal indigestion — becomes hard and impacted, palpable on the right as a firm mass behind the costal arch.

06 The abomasum: the true stomach

Only now do we reach a stomach in the sense a dog or a horse would recognise. The **abomasum** is thin-walled, J-shaped, and lies on the floor of the abdomen mostly to the right of the median plane, with its **fundus** extending across to the left behind the reticulum. It is divided into **fundus, body and pyloric region**, and its mucosa is **glandular** throughout, thrown into about a dozen large **permanent folds** that increase the secretory surface. (Texts differ on their course — the Guide calls them spiral, Budras explicitly oblique rather than spiral — and they diminish toward the pyloric part.)

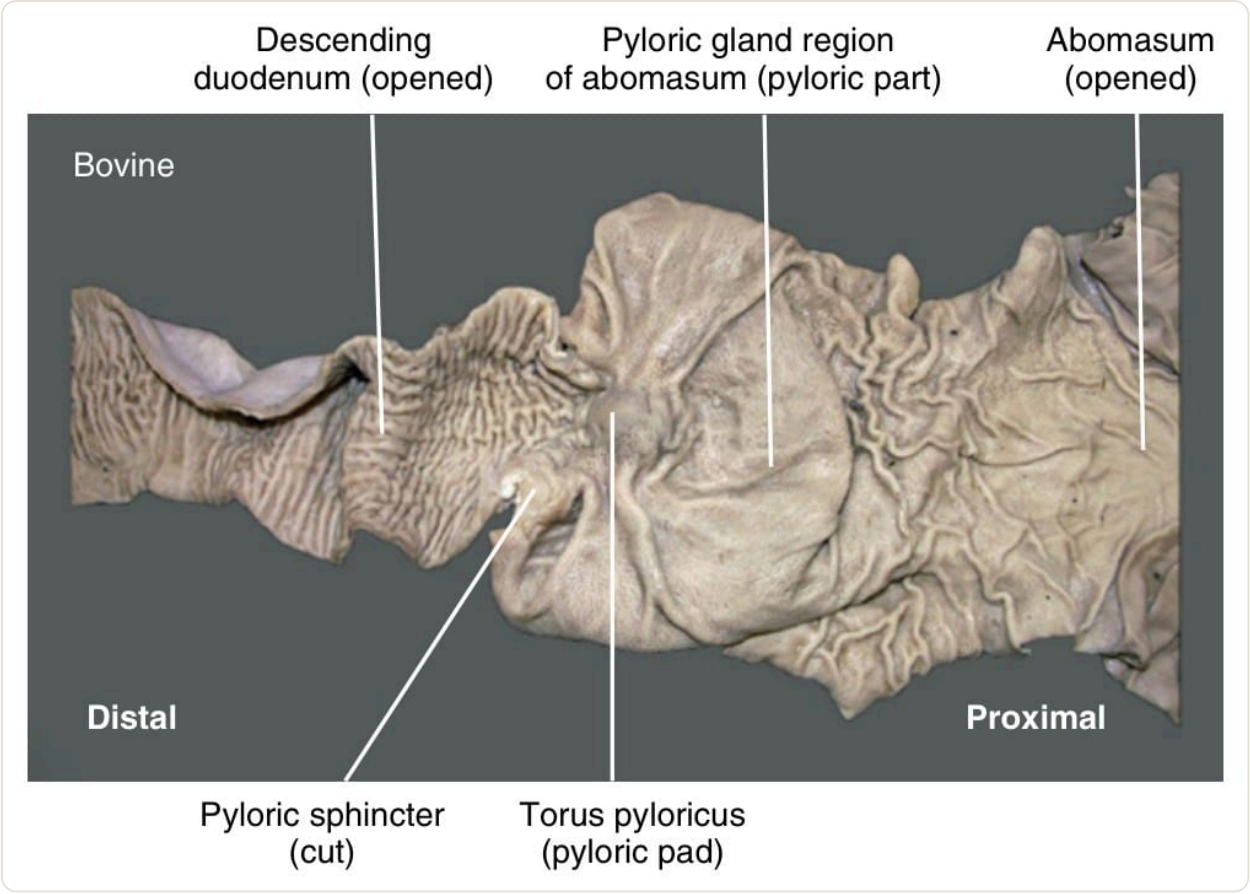

Fig 10 — The abomasum opened, pyloric end. From proximal to distal: the folded glandular body, the **pyloric gland region**, the **torus pyloricus** (a muscular pyloric pad that projects into the lumen and is sometimes mistaken for a mass), the cut **pyloric sphincter**, and the opened **descending duodenum** beyond.

Image — Sarhan MS, Reece WO et al. Guide to Ruminant Anatomy: Dissection and Clinical Aspects , 2nd ed. Wiley — Fig 3.21, bovine abomasum and proximal duodenum. Reproduced for educational reference.

The abomasum secretes **hydrochloric acid** and **pepsinogen** exactly as a simple stomach does — and in the young ruminant it also secretes **rennin (chymosin)**, which clots milk so that it stays long enough to be digested. Much of what it digests is not plant material at all but **microbial protein** washed down from the rumen: the cow, in effect, farms and then eats its own microbes.

07 Topography: what lies where in the live animal

Anatomy that cannot be located in a standing cow is of limited use, and this is where the four compartments become a clinical map. (For the surrounding viscera and the body-wall landmarks these sit behind, see our full Cattle Anatomy guide.) Because the rumen occupies essentially the whole left half of the abdomen, the **left flank belongs to the rumen** and almost nothing else.

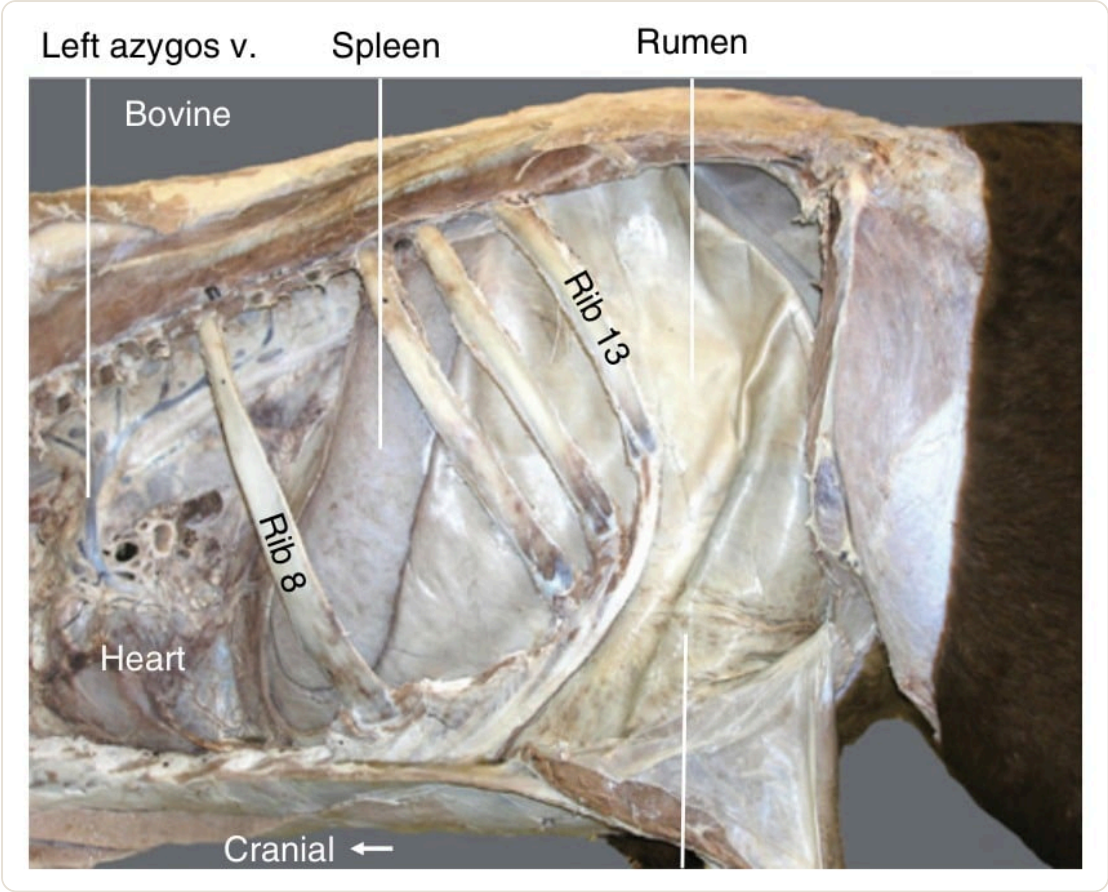

Fig 11 — The rumen in situ, left flank (bovine). With the left body wall removed, the **rumen** reaches from the cardia — at about the **eighth rib** — all the way back to the **pelvic inlet**. The **spleen** is applied to its cranial dorsal surface, and the **heart** lies just beyond the diaphragm — the neighbour that makes reticular foreign bodies so dangerous.

Image — Sarhan MS, Reece WO et al. Guide to Ruminant Anatomy: Dissection and Clinical Aspects , 2nd ed. Wiley — Fig 3.17b, bovine thoracic and abdominal cavities, left lateral. Reproduced for educational reference.

The right side is where everything else lives: the omasum and abomasum, the intestinal mass, the liver, and the descending duodenum. The atlas plate below sets left and right side by side, which is the fastest way to learn what a “left-sided ping” and a “right-sided ping” actually mean.

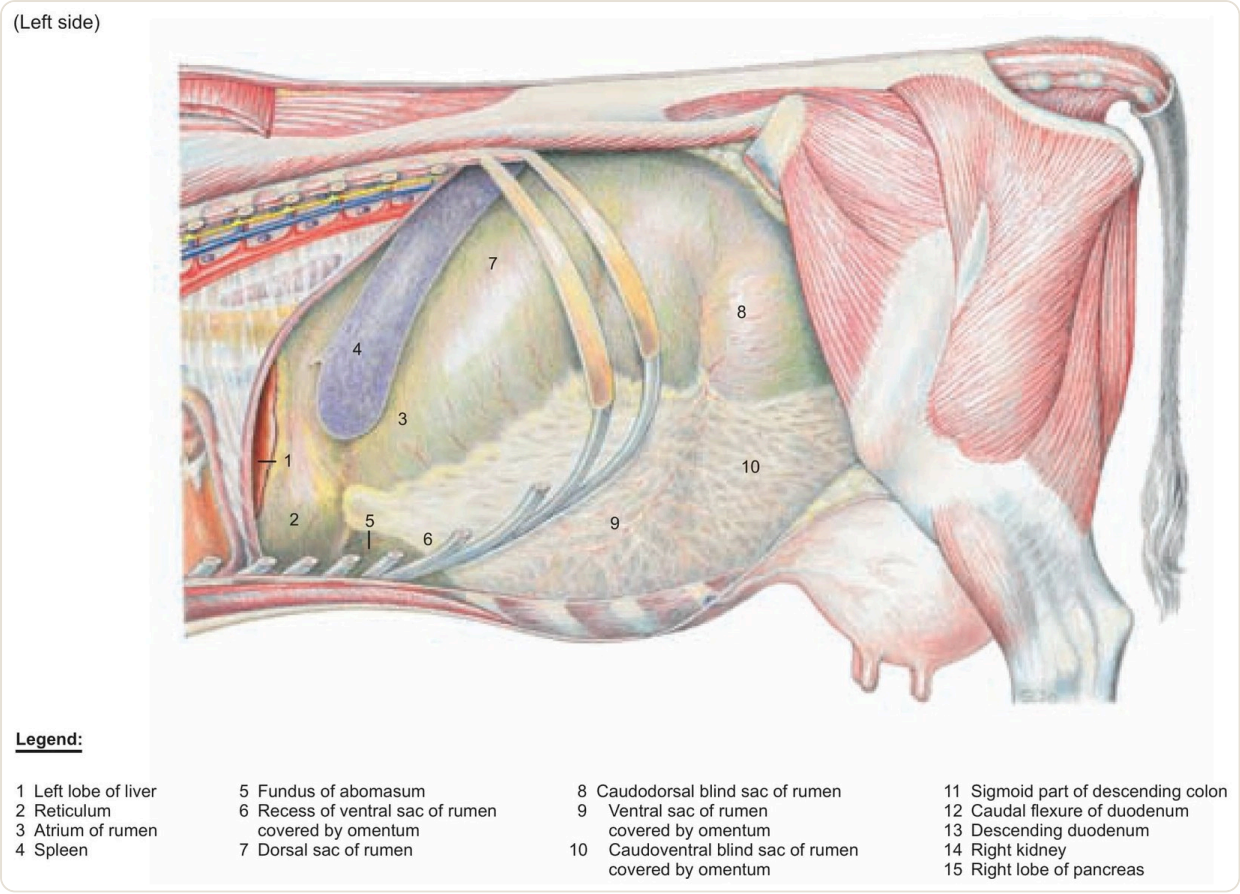

Fig 12 — Abdominal topography, LEFT side. The left flank belongs almost entirely to the rumen: (7) dorsal sac, (9) ventral sac, (8) caudodorsal and (10) caudoventral blind sacs, (3) atrium, (6) recess. The **reticulum** (2) lies furthest cranial and ventral against the diaphragm, with the **spleen** (4) applied to the dorsal rumen and only the **fundus of the abomasum** (5) appearing at the bottom.

Image — Budras KD, Habel RE, Mülling CKW, Greenough PR. Bovine Anatomy: An Illustrated Text , 2nd ext. ed. Schlütersche — Abdominal cavity and Digestive system, p. 69, left side. Reproduced for educational reference.

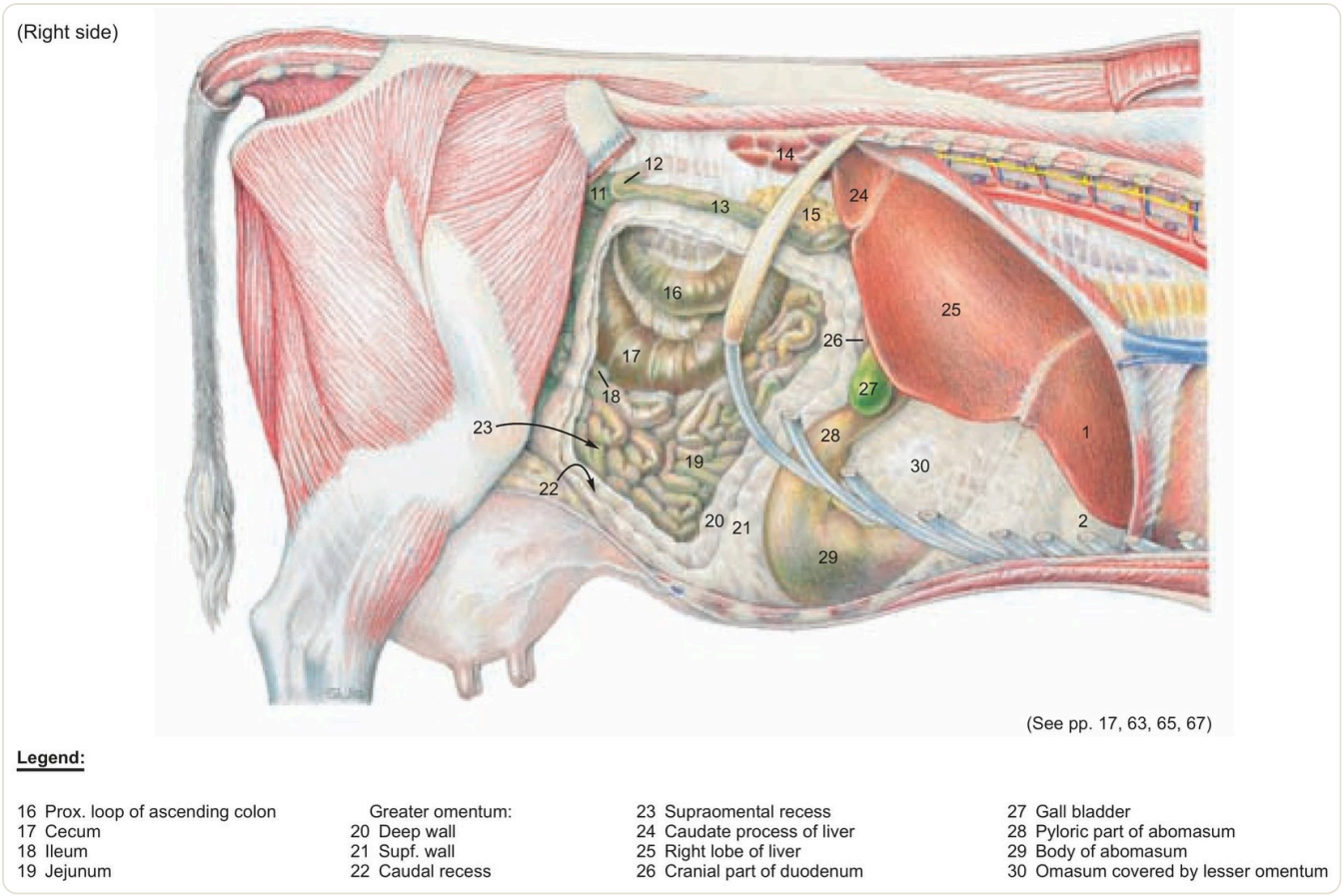

Fig 13 — Abdominal topography, RIGHT side. Everything else lives on the right: the **omasum** (30) under the lesser omentum, the **pyloric part** (28) and **body** (29) of the **abomasum** on the floor, the **liver** (25) and gall bladder (27), the duodenum (26), and the caecum (cecum) and coiled intestinal mass held in the greater omentum with its **supraomental recess** (23). This is the side a right-sided ping comes from.

Image — Budras KD, Habel RE, Mülling CKW, Greenough PR. Bovine Anatomy: An Illustrated Text , 2nd ext. ed. Schlütersche — Abdominal cavity and Digestive system, p. 69, right side. Reproduced for educational reference.

One further structure deserves a mention because it dictates where displaced organs can travel: the **greater omentum**. In ruminants it is enormous, wrapping the intestinal mass and forming the **supraomental recess** — a pocket open caudally through which structures can move.

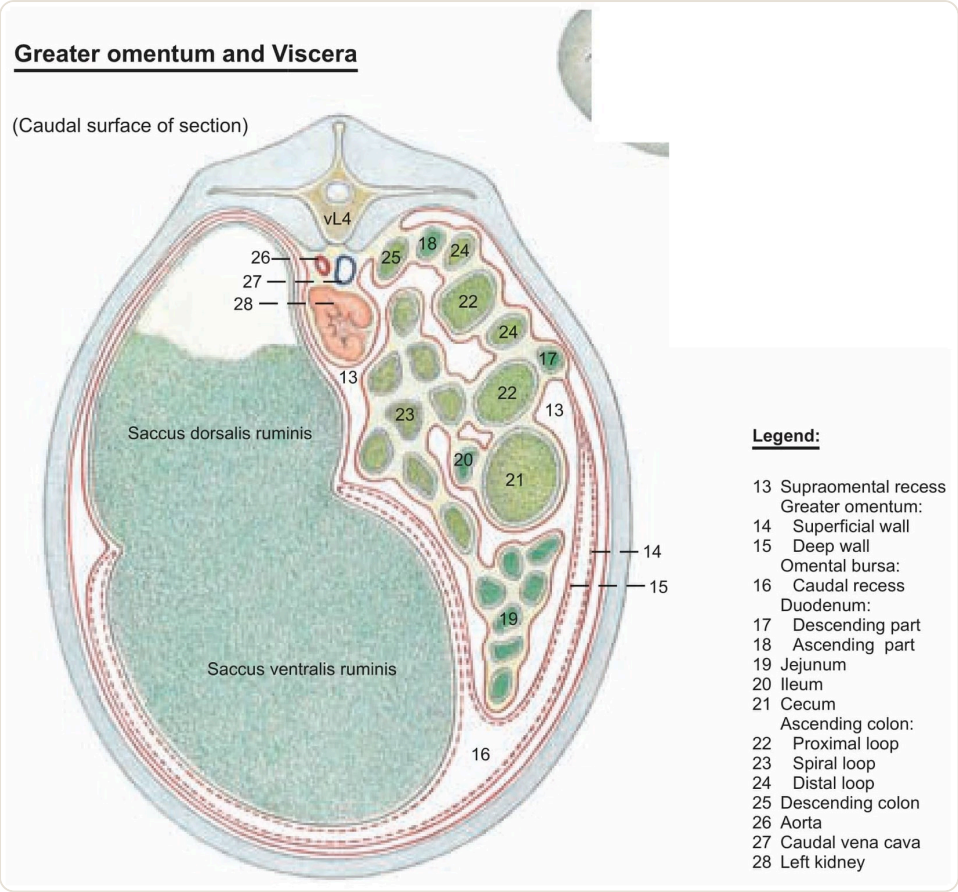

Fig 14 — The greater omentum in cross-section. A transverse section at the fourth lumbar vertebra. The **superficial** (14) and **deep** (15) walls of the greater omentum enclose the **omental bursa** and its caudal recess (16), wrapping the intestinal mass; the **supraomental recess** (13) is the pocket left between the omentum and the sublumbar region. Note the dorsal and ventral ruminal sacs filling the left half of the section.

Image — Budras KD, Habel RE, Mülling CKW, Greenough PR. Bovine Anatomy: An Illustrated Text , 2nd ext. ed. Schlütersche — Greater omentum and Viscera, p. 73. Reproduced for educational reference.

Blood supply and nerve supply of the forestomachs

The forestomachs are supplied from the **coeliac (celiac) artery** — chiefly the right and left **ruminal arteries** running in the longitudinal grooves, with reticular and omasal branches — and drain into the **portal vein**. That venous route is why acidosis-damaged papillae let bacteria reach the liver and seed abscesses. Motor and sensory control is almost entirely **vagal**: the dorsal and ventral vagal trunks pass onto the reticulum and rumen and drive the whole contraction sequence. Interrupt that supply — a hardware lesion, an abscess, lymphosarcoma pressing on the trunk — and the coordinated sequence collapses into **vagal indigestion**.

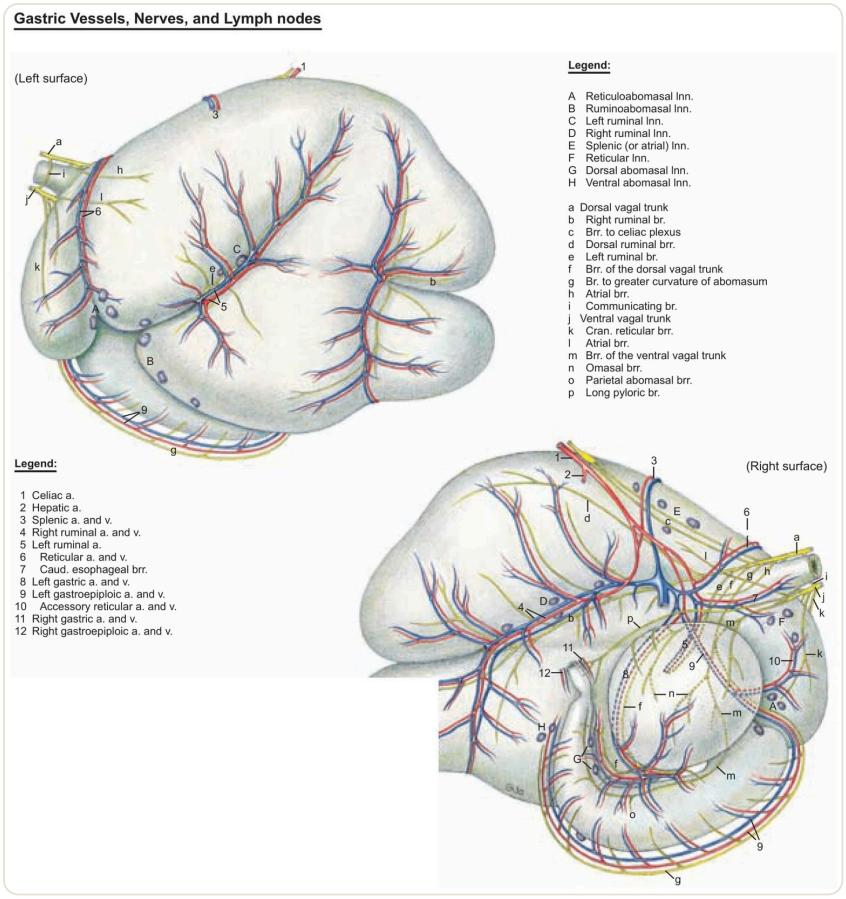

Fig 15 — Gastric vessels, nerves and lymph nodes. Both surfaces of the stomach. Numbered: the **coeliac artery** (1) and its branches — right (4) and left (5) **ruminal** arteries running in the longitudinal grooves, **reticular** (6), gastric and gastroepiploic vessels. Lettered: the **dorsal** (a) and **ventral** (j) **vagal trunks** and their ruminal, reticular, omasal and abomasal branches — the nerve supply whose interruption produces vagal indigestion. Capital letters mark the gastric lymph nodes.

Image — Budras KD, Habel RE, Mülling CKW, Greenough PR. Bovine Anatomy: An Illustrated Text , 2nd ext. ed. Schlütersche — Gastric Vessels, Nerves and Lymph nodes, p. 73. Reproduced for educational reference.

08 How feed actually moves through

Put the compartments in sequence and the design makes sense:

1. **Swallowing** — barely chewed feed passes the cardia into the **atrium ruminis**.
2. **Fermentation and stratification** — it joins the fibre mat in the rumen, where microbes ferment cellulose to **volatile fatty acids** absorbed across the papillae.
3. **Rumination** — coarse material is regurgitated, re-chewed and re-swallowed. A cow may spend eight hours a day doing this.
4. **Sorting** — the **reticulum** contracts in a biphasic cycle. Selection is not made by the calibre of the opening (the dilated **reticulo-omasal orifice** is around 2 cm across, far wider than the 2–3 mm particles that pass it) but by **stratification**: only the dense, fine material lying at the bottom of the reticulum is in the right place to be swept through, and coarse buoyant fibre is returned.
5. **Dehydration** — the **omasum** squeezes and absorbs water and electrolytes between its laminae.
6. **True digestion** — the **abomasum** applies acid and pepsin, largely to microbial protein, before the duodenum.

The oesophagus, rumination and eructation

The ruminant oesophagus is **striated muscle along its entire length**, not merely its proximal third — which is precisely what makes both regurgitation and eructation possible as reflex, and to a degree voluntary, acts. Rumination runs in four phases: **regurgitation** of a bolus, drawn up by an inspiratory effort against a closed glottis; **remastication**; **reinsalivation**; and **redeglutition**. Eructation is the secondary cycle, and it has a requirement worth remembering: the gas cap must be sitting over a **cardia clear of fluid and froth**. The belched gas is then largely inhaled and expired through the lungs rather than passing out of the mouth. Every one of those requirements is a way for a sick ruminant to bloat.

Two motility patterns run this: a **primary (mixing) cycle** beginning with a double reticular contraction that sweeps ingesta around the sacs, and a **secondary (eructation) cycle** that moves the gas cap forward to be belched. That cycle depends on the ventral sac *relaxing* so the fluid level drops clear of the cardia — which is exactly what froth prevents. Losing either is what makes a sick ruminant bloat.

09 From calf to cow: the stomach changes shape

A newborn calf is functionally a **monogastric**. At birth the **abomasum is the largest compartment** — it has more capacity than all the others combined — while the forestomachs are small, collapsed and essentially without a microbial population. Milk, directed past them by the **reticular groove**, goes straight to the abomasum.

As the calf begins to take solid feed, the rumen is colonised by microbes, the fermentation of solid feed (and especially the volatile fatty acids produced from it) drives the **papillae to develop**, and the rumen enlarges rapidly. The rumen and reticulum together generally overtake the abomasum by about **8 weeks** and are more than twice its size by **12 weeks**; when the adult proportions are fully settled is debated, with estimates from three months to a year. This is precisely why calf-rearing protocols push early access to solid starter feed: **papillary development is what makes a functioning ruminant**.

10 The clinical payoff

Nearly every common forestomach disease is an anatomical fact playing out:

CONDITION	THE ANATOMY BEHIND IT
Bloat (ruminal tympany)	Gas normally collects in the **dorsal sac** and is belched via the cardia. Anything that blocks eructation — froth, oesophageal obstruction, a recumbent animal — distends the dorsal sac — classically taught as the **caudodorsal blind sac** first — so the left flank bulges, in severe cases uniformly up to the dorsal midline
Hardware disease (traumatic reticuloperitonitis)	The **reticulum** is the most cranial and most ventral compartment, lying against the diaphragm at about the level of the **6th–8th ribs** — directly in front of the **heart**. Heavy swallowed metal drops in, and reticular contractions drive it forward through the wall toward pericardium and diaphragm
Left displaced abomasum (LDA)	The abomasum normally lies on the abdominal floor to the **right** of midline. When it fills with gas it can slide **left**, between the rumen and the body wall — giving the classic high-pitched left-sided 'ping'
Right displacement (RDA) and abomasal volvulus	Two stages, not one. Right displacement is **less common than LDA**; the organ moves right and dorsally, and the ping is right-sided. It *may* then progress to a complete **volvulus** — a twist that is a genuine surgical emergency with a far sicker animal
Vagal indigestion	Damage to the vagal supply of the forestomachs (often from hardware disease) disrupts the motility sequence and the reticulo-omasal orifice, causing ingesta to pile up. Rebhun's describes the result as an **L-shaped rumen** on rectal and external examination, becoming a **V shape** when severe (the same picture is widely called a 'papple'-shaped abdomen)
Ruminal acidosis / grain overload	Rapidly fermented starch drops ruminal pH, damaging the **papillae** that absorb volatile fatty acids and letting bacteria enter the portal blood — the route to liver abscessation
Rumen fluke (paramphistomosis)	A different disease entirely. The **adult** flukes attach in the rumen and reticulum and are usually well tolerated; the damage is done by the **immature** flukes, which migrate through the duodenal and abomasal wall *before* reaching the forestomachs. The clinical picture is therefore enteritis, diarrhoea and hypoproteinaemia — not a forestomach sign
Abomasal ulceration	The abomasum is the only compartment that secretes acid, so it is the only one that ulcerates. Ulcers concentrate in the **fundic** region — common in high-yielding fresh cows and in calves — and range from a subclinical bleed (melaena, anaemia) to perforation
Ketosis and the LDA	The two travel together. Negative energy balance after calving cuts intake, so the rumen shrinks away from the abdominal floor and leaves room; hypocalcaemia (hypocalcemia) and high-concentrate rations reduce abomasal motility, and a hypomotile gas-filled abomasum is exactly the organ that floats left

Frothy bloat vs free-gas bloat

The anatomy is identical; the contents are not, and that is what decides the treatment. In **free-gas bloat** the gas sits as a discrete cap over the fluid, so a stomach tube passed to the cardia relieves it at once — and so will trocarisation of the left paralumbar fossa. The cause is usually a physical or functional block to eructation: choke, a vagal lesion, or simply a recumbent animal whose cardia is submerged. In **frothy (primary) bloat** the gas is dispersed through the ingesta as a stable foam, typically after lush legume pasture or a finely ground concentrate ration. The froth bathes the cardia and inhibits the eructation reflex, and a tube or trocar promptly plugs with foam. That one needs an **antifoaming agent** — poloxalene, mineral or vegetable oil — and, in an animal that is going down, an emergency rumenotomy.

Reading the left flank

Distension high on the **left** is the rumen's dorsal sac and its caudodorsal blind sac — the picture of **bloat**. Normal rumen contractions — roughly **one to three per minute** — are heard and felt in the same place, and their absence in a sick cow is a genuine finding.

The magnet, and how you actually find a ping

Because the reticulum is where swallowed wire ends up, the standard prophylaxis is to put something there to hold it. A **rumen magnet** — a smooth cylindrical alnico or cage magnet — is given by balling gun, sinks into the reticulum and stays there for the life of the animal, gripping ferrous objects against the wall so they cannot penetrate. It is routine in dairy heifers before first calving, and giving one is part of the conservative treatment of traumatic reticuloperitonitis alongside antibiotics and stall confinement, with rumenotomy kept for the cases that do not respond.

Finding gas where it should not be is a technique with a name: **simultaneous auscultation and percussion**. Hold the stethoscope against the flank and flick the body wall sharply with a fingertip just beside it; a gas-filled viscus under tension returns a high, resonant **ping**. Where the ping is tells you what it is — high on the *left* behind the ribs is the classic left displaced abomasum, whereas a ping on the *right* raises right displacement, abomasal volvulus or caecal (cecal) dilatation, and those are surgical decisions on a different timescale. **Succussion** — rocking the abdomen firmly while listening — adds the fluid half of the picture: an audible splash means a fluid-filled viscus, which alongside a ping suggests the gas and fluid interface of a displacement rather than simple bloat.

Where to place a trocar or do a rumenotomy

The **left paralumbar fossa** is the standard site, because the rumen lies immediately against the body wall there with no other viscus in the way.

Rumenocentesis: a different site from the trocar

Rumenocentesis samples the **ventral sac** to get a true ruminal pH, and it is deliberately *not* done through the paralumbar fossa. The site is low on the left, roughly a hand's breadth caudal to the costochondral junction of the last rib and about the same distance left of midline, directed into the ventral sac where the fluid actually sits. Fluid drawn up a stomach tube is contaminated with saliva and reads a falsely high pH — which is how SARA gets missed.

Why hardware disease presents as it does

The reticulum sits against the diaphragm with the **heart** just beyond. A migrating wire therefore produces localised pain, a reluctance to move, an arched back and a grunt — and in the worst case traumatic **pericarditis**.

11 Sheep, goats and camelids

Sheep and goats share the same four-compartment plan as cattle on a much smaller scale; the plates in this guide are from cattle and goats precisely because the arrangement is so consistent. The proportions differ more than you might expect, though: in sheep and goats the rumen is roughly **75%** of the stomach and the **abomasum nearly 13%** — almost double the bovine share — while the **omasum is relatively much smaller** and the reticulum relatively larger. Nor is every landmark present: the **dorsal coronary pillars are absent in sheep**, and the left longitudinal pillar is described as indistinct in small ruminants.

Camelids are the exception that proves the rule. Llamas and alpacas are **pseudoruminants** — they ruminate in behaviour but are not classified with the true ruminants, and their stomach has only **three compartments** (conventionally C1, C2 and C3) rather than four, with glandular saccules in all three chambers (their secretory role in C1 and C2 is doubtful) and fermentation occupying C1, C2 and the cranial four-fifths of C3, so that acid secretion is confined to its **distal fifth**. Do not simply transfer bovine landmarks onto an alpaca.

For the wider comparison — where the ruminant plan sits against the simple stomach of a dog or a cat, and the hindgut-fermenter design of a horse — see our full anatomy guides.

12 Quiz: test yourself (15 questions)

Cover the answers and work down the list. These are the points most often examined in **ruminant stomach anatomy** and most often needed on a farm call.

SELF-TEST1. Name the four compartments of the ruminant stomach in order, and say which is the true stomach.**Answer: Rumen → reticulum → omasum → abomasum.** Only the **abomasum** is glandular and is the true stomach, homologous with the simple stomach of a dog.2. Which three compartments are non-glandular, and what lines them?**Answer: Rumen, reticulum and omasum** — the forestomachs — all lined by **non-glandular stratified squamous** epithelium.3. Roughly what proportion of the adult ruminant stomach is rumen?**Answer:** About **80%**. The reticulum is around 5% and the omasum and abomasum roughly 7–8% each.4. What are the ruminal pillars, and what do they do? **Answer:** Thick **muscular ridges** of the wall that project into the lumen. They divide the rumen into its sacs (dorsal, ventral, cranial, and the two

blind sacs) and generate the mixing contractions.5. Which sac tympanises first in bloat, and where do you see it?**Answer:** The **caudodorsal blind sac** of the dorsal ruminal sac — visible as distension of the **left paralumbar fossa**.6. Why is the reticulum the compartment involved in hardware disease?**Answer:** It is the **most cranial and most ventral** compartment, sitting against the diaphragm opposite the heart, so heavy swallowed metal falls into it and its contractions drive the object forward.7. What is the reticular groove and when does it matter?**Answer:** A groove running from the **cardia** to the **reticulo-omasal orifice**. In the suckling calf its lips close into a tube so **milk bypasses the forestomachs** and enters the abomasum directly.8. Why does the omasum have laminae?**Answer:** The stacked **omasal laminae** (like the pages of a book) massively increase surface area for squeezing ingesta and absorbing **water, sodium and residual VFAs**.9. Which structures does the gastric groove comprise?**Answer:** The **reticular, omasal and abomasal grooves** in sequence — a continuous channel along the lesser curvature of the stomach.10. Where does the oesophagus enter, and what is that opening called?**Answer:** At the **cardia**, at the top of the **atrium ruminis** (cranial sac) at the ruminoreticular junction — positioned so gas in the dorsal sac can be belched.11. Where does the abomasum normally lie, and why does that matter clinically?**Answer:** On the **abdominal floor, mostly to the right of midline**, with its fundus reaching left. Gas distension lets it slide left (LDA) or right and twist (RDA/volvulus).12. What is the torus pyloricus?**Answer:** A muscular **pyloric pad** projecting into the lumen at the abomasal pylorus — normal, but sometimes mistaken for a mass.13. Which compartments does a newborn calf rely on, and what happens as it weans?**Answer:** At birth the **abomasum** is the largest compartment — bigger than all the others combined — and the forestomachs are small, collapsed and essentially without a microbial population. As the calf starts eating solid feed the rumen is colonised and the **volatile fatty acids** produced drive papillary development; rumen and reticulum overtake the abomasum by about 8 weeks.14. What is the reticulo-omasal orifice and why is it important?**Answer:** The opening from reticulum to omasum. It is often called a particle-size filter, but the dilated orifice is about **2 cm** across — far wider than the particles passing it. Selection actually depends on **stratification**: only the fine, dense material at the bottom of the reticulum is positioned to be swept through, so coarse buoyant fibre is regurgitated and re-chewed.15. Which surface of the cow do you auscultate for the rumen, and why?**Answer:** The **left** flank — the rumen fills essentially the whole left half of the abdomen, so normal contractions are heard in the left paralumbar fossa.

13 Ruminant stomach anatomy — frequently asked questions

Do cows really have four stomachs?

Not quite. A cow has **one stomach with four compartments** — rumen, reticulum, omasum and abomasum. The first three are non-glandular **forestomachs**; only the **abomasum** secretes acid and enzymes, so only it is a true stomach.

What are the four compartments in order?

Rumen → reticulum → omasum → abomasum. Feed ferments in the rumen, is sorted by the reticulum, dehydrated between the omasal laminae, and finally digested with acid and pepsin in the abomasum.

Which is the true stomach of a ruminant?

The **abomasum**. It is the only glandular compartment and the only one homologous with the simple stomach of a dog, cat or horse.

How many stomachs does a cow have?

Strictly, one. A cow has a **single stomach divided into four compartments** — rumen, reticulum, omasum and abomasum — and only the abomasum is a true, acid-secreting stomach. The "four stomachs" phrasing is convenient shorthand, not anatomy.

What is the difference between the rumen and the reticulum?

They are continuous over the **ruminoreticular fold** and are usually treated as one functional **ruminoreticular compartment**, but they differ in three ways: the rumen is vastly larger, its lining carries **papillae** where the reticulum carries a **honeycomb** of crests and cells, and the reticulum sits furthest forward and lowest — which is why foreign bodies end up there and gas does not.

Why do cows chew the cud?

Rumination returns coarse fibre to the mouth to be re-chewed, reducing particle size so it can pass the reticulo-omasal orifice — and, just as importantly, it triggers several hours a day of **salivation**, delivering the bicarbonate buffer that keeps ruminal pH in range. A cow that stops chewing the cud is a cow whose rumen is in trouble.

What is the reticular (oesophageal) groove?

A muscular groove from the **cardia** to the **reticulo-omasal orifice**. In the suckling calf its lips close into a tube so **milk bypasses the forestomachs** and enters the abomasum directly, where it can be clotted by rennin.

Why is the reticulum called the honeycomb?

Because its non-glandular lining is raised into **reticular crests** that divide the surface into four- to six-sided **cells**, giving an unmistakable honeycomb pattern.

Why does hardware disease involve the reticulum?

The reticulum is the **most cranial and most ventral** compartment, sitting against the diaphragm with the heart just beyond. Heavy swallowed metal falls into it, and its strong contractions drive the object forward through the wall — sometimes as far as the pericardium.

Which side do you listen to for the rumen?

The **left**. The rumen fills virtually the entire left half of the abdomen, so contractions are auscultated and palpated in the **left paralumbar fossa** — the same site used for trocarisation and rumenotomy.

How is the ruminant stomach different from a horse's or a dog's?

A dog has a single glandular stomach and does no significant fermentation. A horse ferments too, but in the **hindgut** (caecum and colon) *after* gastric digestion. The ruminant is unusual in fermenting **before** the true stomach, which lets it digest the microbes themselves. Compare our Dog Anatomy and Horse Anatomy guides.

When to refer

- **Bloat** — gas in the dorsal sac and caudodorsal blind sac; distension of the left paralumbar fossa.
- **Hardware disease** — the reticulum lies against the diaphragm opposite the heart.
- **Left displaced abomasum** — a normally right-sided organ floating left between rumen and body wall.
- **Rumenotomy / trocarisation** — the left paralumbar fossa, where the rumen meets the body wall directly.
- **Oral dosing** — without groove closure your drench goes to the rumen, not the abomasum.
- **Calf rearing** — solid feed drives papillary development; that is what turns a monogastric calf into a ruminant.
- **Transfaunation** — where the microbial population itself is lost, several litres of strained rumen fluid from a healthy donor repopulates it.

Sources

1. Sarhan MS, Reece WO, et al. *Guide to Ruminant Anatomy: Dissection and Clinical Aspects*. 2nd ed. Wiley — source of the dissection photographs and schematics; the abdomen chapter covers the forestomachs in detail.
2. Budras KD, Habel RE, Mülling CKW, Greenough PR. *Bovine Anatomy: An Illustrated Text*. 2nd ext. ed. Schlütersche — source of the atlas plates and the numbered legends.
3. Dyce KM, Sack WO, Wensing CJG. *Textbook of Veterinary Anatomy*. 5th ed. Elsevier — comparative and topographical reference.
4. WikiVet — Rumen: Anatomy & Physiology — open revision notes on the forestomachs.

Vet eBooks
VET-EBOOKS.COM

MORE FREE STUDY GUIDES · RESOURCES

More free veterinary study guides

This is one of a growing library of free veterinary study guides on vet-ebooks.com — written for practising vets and students, sourced from the standard veterinary texts, and every one free with a downloadable PDF and no sign-up.

3,400+
veterinary books

400+
drug profiles

Study guides
a free PDF with each

All free
no sign-up needed

www.vet-ebooks.com