1st lesson Scientific english 1st and 2nd year Veterinary Sciences

In the 18th century, the Swedish scientist Carl Linnaeus (1707–1778) created

a revolutionary system for naming and classifying all living organisms. Before his work, scientific names were long, inconsistent, and varied from country to country. Linnaeus's great contribution was the establishment of a hierarchical classification system and a consistent method of naming, known as binomial nomenclature. This system brought order to the natural world and remains the foundation of modern taxonomy (the science of naming, defining, and classifying organisms).

Binomial Nomenclature: The Two-Name System

The core of Linnaeus's method is binomial nomenclature ("bi" meaning two, "nomial" meaning name). Each species is given a unique, two-part Latin name:

· The first part is the genus (plural: genera). It is always capitalized. The genus groups together closely related species.

· The second part is the specific epithet. It is always written in lowercase.

The entire name is written in italics (or underlined when handwritten).

Example: Felis catus (the domestic cat). Felis is the genus, which also includes Felis silvestris (the wildcat). Canis lupus (the grey wolf) belongs to a different genus (Canis), showing a more distant relationship.

The Hierarchical Classification

Linnaeus organized life into a nested hierarchy of groups, from the broadest to the most specific. The main ranks are:

· Kingdom (broadest category, e.g., Animalia)

· Phylum (e.g., Chordata – animals with a spinal cord)

· Class (e.g., Mammalia – warm-blooded animals with hair that feed their young milk)

· Order (e.g., Carnivora – meat-eating mammals)

· Family (e.g., Felidae – the cat family)

· Genus (e.g., Felis)

· Species (most specific category, e.g., catus)

A common mnemonic to remember this order is: King Philip Came Over For Good Soup.

Example of a Full Classification for a Human:

· Kingdom: Animalia

· Phylum: Chordata

· Class: Mammalia

· Order: Primates

· Family: Hominidae

· Genus: Homo

· Species: sapiens

· Scientific name: Homo sapiens

Linnaeus's original system was based primarily on morphological (physical and structural) similarities that he could observe. He did not know about evolution or genetics. Today, while we still use his naming system and basic hierarchy, modern taxonomy heavily incorporates DNA analysis and evolutionary history (phylogenetics). This sometimes leads to the reclassification of organisms as we understand their true relationships better. Furthermore, Linnaeus originally recognized only two kingdoms (Plants and Animals), while scientists now use at least six.

Linnaeus's system provided a universal language for biologists. By giving every species a precise, stable name and a logical place in the tree of life, he enabled clear communication and systematic study across the globe. His work is a cornerstone of biology, demonstrating the power of organization in scientific understanding.

Key Vocabulary & Comprehension Questions

Give the key words in this text.

Comprehension Questions:

1. What were the two main contributions of Carl Linnaeus to biology?

2. How do you correctly write the scientific name for the domestic cat?

3. List the seven main taxonomic ranks in order, from broadest to most specific.

4. What is the primary difference between modern taxonomy and Linnaeus's original system?

5. To which genus do humans belong? Write the full scientific name for our species.

6. Give a title to the text

7. Give titles to each paragraph

8. Give the significance of these words

. Classification / Taxonomy, Binomial Nomenclature, Hierarchy, Genus, Species:

Put the classification of these animals:

Cow, sheep, goat, deer, horse, camel, rabbit, chicken, turkey, geese.

2nd lesson

Mammals are a diverse group of vertebrates belonging to the Class Mammalia. They are distinguished from other vertebrates by a set of unique anatomical and physiological features. A thorough understanding of these characteristics is essential before specializing in individual species.

· Mammary Glands: The presence of mammary glands, which in females produce milk (lactation) to nourish offspring, is the defining characteristic from which the class derives its name.

· Hair/Fur: All mammals possess hair follicles that produce keratinized filaments. Hair serves multiple functions, including insulation (thermoregulation), sensory perception (vibrissae or whiskers), camouflage, and social signaling.

· Auditory Ossicles: The middle ear contains three tiny bones—the malleus, incus, and stapes—that transmit sound vibrations from the tympanic membrane to the inner ear. This structure is unique to mammals.

· Heterodont Dentition: Mammalian teeth are generally differentiated into four types: incisors (for cutting), canines (for tearing), premolars, and molars (both for grinding). This specialization allows for complex processing of food.

· Endothermy (Warm-bloodedness): Mammals are homeothermic endotherms, meaning they maintain a relatively constant internal body temperature through internal metabolic processes. This is supported by insulation (hair, fat) and sophisticated thermoregulatory centers in the brain.

· Diaphragm: Respiration is facilitated by a muscular diaphragm, which separates the thoracic and abdominal cavities and is the primary muscle of inspiration.

· Four-Chambered Heart: A completely divided heart ensures complete separation of oxygenated and deoxygenated blood, supporting a high metabolic rate.

· Reproduction: While predominantly viviparous (giving birth to live young), mammals exhibit variation:

  · Eutherians (Placentals): Most domestic mammals (cattle, sheep, goats, horses, pigs). Development occurs in utero with a complex placenta for nutrient and gas exchange.

  · Marsupials: Birth occurs at a very early developmental stage, with development often completing in a pouch.

From a veterinary and agricultural perspective, livestock are domesticated animals raised in an agricultural setting to produce commodities such as food, fiber, and labor. They are broadly categorized based on their digestive physiology and production purpose.

Ruminants (Suborder Ruminantia)

Ruminants are hoofed mammals that have evolved a specialized, four-compartment forestomach to digest cellulose-rich plant material through microbial fermentation. This process occurs before the food reaches the true stomach (abomasum). The four compartments are the rumen, reticulum, omasum, and abomasum.

Cattle (Bos taurus and Bos indicus)

· Taxonomy: Family Bovidae.

· Biological Distinction: Cattle are the most prominent ruminant livestock. Bos taurus (taurine cattle) are adapted to temperate climates, while Bos indicus (zebu cattle) are characterized by a hump over the shoulders and are adapted to tropical environments. Hybrids are common.

· Digestive Physiology: The rumen is a large fermentation vat housing a complex microbiome of bacteria, protozoa, fungi, and archaea. These microbes break down cellulose and hemicellulose into volatile fatty acids (VFAs)—primarily acetate, propionate, and butyrate—which are absorbed across the rumen wall and serve as the cow's main energy source. Microbial protein synthesized in the rumen is digested in the small intestine, providing a major source of amino acids.

· Production Categories:

  · Dairy: Specialized for high milk production (e.g., Holstein-Friesian, Jersey).

  · Beef: Bred for efficient muscle growth and carcass quality (e.g., Angus, Hereford).

  · Dual-Purpose: Bred for both moderate milk and meat production.

Sheep (Ovis aries)

· Taxonomy: Family Bovidae.

· Biological Distinction: Sheep are small ruminants primarily valued for their wool, meat (lamb/mutton), and milk. They are grazers, preferring to eat short, tender grasses. Key anatomical features include a divided upper lip (philtrum) allowing them to graze very close to the ground and the presence of infraorbital, inguinal, and interdigital scent glands used for communication.

· Digestive Physiology: Similar to cattle, but with a smaller rumen relative to body size and a faster rate of passage. They are more efficient at digesting low-quality forage than cattle.

· Production Categories:

  · Wool: Bred for fine, high-quality fleece (e.g., Merino).

  · Meat: Bred for rapid growth and muscling (e.g., Suffolk, Dorset).

  · Dairy: Bred for milk production, often for cheese making (e.g., East Friesian).

Goats (Capra hircus)

· Taxonomy: Family Bovidae.

· Biological Distinction: Goats are small ruminants that are primarily browsers, preferring to eat leaves, twigs, vines, and shrubs over grass. They are highly curious and agile animals. Many breeds have horns, and most have a short, upward-curving tail. They are known for their adaptability to harsh environments.

· Digestive Physiology: While functionally similar to sheep, goats have a more efficient digestive system for processing tannins and other secondary plant compounds found in browse. They also have a greater salivary capacity to buffer rumen pH when consuming highly fermentable feeds.

· Production Categories:

  · Dairy: Bred for high milk production, which has different fat and protein characteristics than cow's milk (e.g., Saanen, Alpine, Nubian).

· Meat: Bred for carcass yield (e.g., Boer, Kiko).

· Fiber: Bred for specialized hair/fiber production like mohair (Angora) and cashmere (Cashmere goat).

Comprehension Questions: Mammals and Livestock Categories

PART A:

Define the following terms as they are used in the text. Use a complete sentence for each:

Viviparous, Heterodont Dentition, Rumen.

PART B: Reading Comprehension

Answer the following questions based explicitly on the text.

1. List four of the defining characteristics of the Class Mammalia mentioned in the text.

2. What is the primary physiological function of the hair on a mammal?

3. Name the three bones in the mammalian middle ear.

4. What is the main structural difference between the heart of a mammal and that of a reptile (implied by "four-chambered heart")?

5. According to the text, what is the fundamental difference between Bos taurus and Bos indicus cattle?

6. How do sheep and goats differ in their natural feeding behavior (grazing vs. browsing)?

PART C: True or False (10 points)

Indicate whether the following statements are True (T) or False (F) based on the text. If false, correct the statement to make it true.

1. T / F: All mammals give birth to live young.

2. T / F: The rumen is the "true stomach" of a cow where gastric juices are secreted.

3. T / F: Goats are generally more efficient at digesting tannins found in shrubs than sheep are.

4. T / F: A Holstein cow is primarily classified as a beef breed.

Scientific english **1st and 2nd year Veterinary Sciences**

3rd lesson

In the field of animal science and agriculture, precise terminology is used to describe different categories of livestock based on age, sex, and reproductive status. This vocabulary is essential for farmers, veterinarians, and researchers to communicate effectively about animal management, breeding programs, and production systems.

Cattle (Bovines): Cattle are among the most important livestock species worldwide, raised for meat (beef), milk (dairy), and leather. The terminology for **cattle** varies significantly.

- **A calf** is a young bovine of either sex, typically under one year old. As calves grow, they are weaned from their mother's milk and begin grazing.

- **A bullock or young bu**ll is a young male bovine, usually between one and two years old, that has not yet reached full maturity. If a young male is castrated, he becomes a steer or ox. Steers are often raised for beef production because they are more docile and their meat is considered of higher quality. An intact adult male used for breeding is called a bull.

For females, a young cow that has not yet had a calf is called a **heifer**. Heifers are typically between one and two years old. In cattle, after a heifer gives birth, she becomes a cow. A mature female that has given birth to multiple calves is simply called a **cow.**

Sheep (Ovine): Sheep farming is primarily focused on wool, meat (lamb and mutton), and milk (for cheese, like Roquefort).

A newborn sheep is called a **lamb**. This term is used for both males and females until they are about one year old. The meat from a young sheep is also called lamb.

A young female sheep between **weaning** and her first birthday is called an **ewe lamb or yearling ewe.** A young ewe that has not yet been bred or given birth is called a hogg. Once this female matures and has given birth, she becomes an **ewe**.

A young male sheep is called a **ram**. If he is castrated, he becomes a wether. An intact adult male used for breeding is called a ram, **a two tooth** is a two year old sheep.

Goats (Caprine): Goats are versatile animals raised for their meat, milk (used for cheese and soap), and fiber (mohair from Angora goats, cashmere from Cashmere goats). They are known for their curious nature and ability to browse on shrubs and weeds that cattle might ignore.

A newborn goat is called a **kid**. Like lambs, kids are playful and stay close to their mothers for the first few weeks of life. Both male and female babies are called kids.

As they grow, the terminology becomes more specific. A young female goat that has not yet given birth is called a **doeling**. Once this female has matured and given birth to her first kid, she becomes a **doe or nanny goat**.

A young male goat is called a **cabri or buckling**. If this male is castrated, he becomes a **wether**, which is often calmer and easier to manage. An intact adult male used for breeding is called a **buck or billy goat**. **Bucks** are famous for their strong odor, especially during the breeding season (rut), which they use to attract does.

Rabbits (Lagomorphs)

While technically lagomorphs (not rodents), rabbits are commonly raised in small-scale and commercial agriculture for their meat (a lean, white meat), fur, wool (from Angora rabbits), and as laboratory animals. They are known for their rapid reproductive rate. A newborn rabbit is called a kit or kitten. Kits are born hairless, blind, and completely dependent on their mother. A female rabbit is called a (doe). **Does** are responsible for nursing and caring for the young. They can become pregnant again very soon after giving birth. A male rabbit is called a **buck**. Bucks can be housed with does for breeding, but they must be separated after mating to prevent fighting or overbreeding. In a farming context, the term "breeder" might be used for both sexes, but the specific terms help clarify their roles in reproduction.

Comprehension Questions

Part 1: Short Answer Questions

1. What is the English term for a calf," and how is it generally defined?
2. What is the main difference between a "bull" and a "steer"?
3. At what point does a heifer stop being called a heifer?
4. What is the primary use of a bull on a farm?
5. Describe the difference between a lamb and an ewe.
6. What is a ram and what is its role in sheep farming?
7. What are three primary products obtained from goats?
8. What is the English term for a newborn rabbit?

Part 2: Fill in the Blanks

1. A young female sheep that has not yet given birth is called an _____ .
2. An intact adult male bovine used for breeding is simply called a _____.
3. A young male bovine that has been castrated is called a_____.
4. A young male goat that has been castrated is called a _____.
5. A female goat that has given birth is called a _____ or .
6. Rabbit kits are born _____ and , requiring full maternal care.

Part 3: True or False

1. A (steer) is an intact male bovine used for breeding. (True / False)
2. An (ewe) is a female sheep that has given birth. (True / False)
3. Weaning is the interruption of lactating a calf by his mother. (True / False)
4. A "cabri" is an adult female goat. (True / False)
5. Rabbits are classified as rodents in animal science. (True / False)
6. The meat from rabbits is known for being dark and fatty. (True / False)

Scientific english 1st and 2nd year Veterinary Sciences

4th Lesson: Organs in Mammals

Key Vocabulary

Organ – A group of tissues that performs a specific function.

Mammal – A warm-blooded animal with a backbone, hair/fur, and (in females) milk-producing glands.

System – A group of organs working together.

1. The Brain

Location: Head, inside the skull.

Function: Controls all body activities, thoughts, memory, and senses.
Example sentence: *The brain receives signals from the eyes and ears to help the mammal react to danger.*

2. The Heart

Location: Chest, slightly to the left.
Function: Pumps blood throughout the body, delivering oxygen and nutrients.
Example sentence: *A mammal's heart has four chambers: two atria and two ventricles.*

3. The Lungs

Location: Chest, on either side of the heart.
Function: Exchange oxygen and carbon dioxide during breathing.
Example sentence: *When a mammal inhales, the lungs expand to take in oxygen.*

4. The Stomach

Location: Upper left part of the abdomen.
Function: Breaks down food using acids and enzymes.

Example sentence: *Some mammals, like cows, have a stomach with multiple compartments.*

5. The Liver

Location: Upper right part of the abdomen, below the diaphragm.
Function: Filters toxins from the blood, produces bile for digestion, stores energy.
Example sentence: *The liver is the largest internal organ in most mammals.*

6. The Kidneys (two)

Location: Lower back, on either side of the spine.
Function: Filter waste from the blood to produce urine.
Example sentence: *Mammals need healthy kidneys to maintain water and salt balance.*

7. The Intestines (Small and Large)

Location: Lower abdomen.

Functions:

Small intestine: Absorbs nutrients from digested food.

Large intestine: Absorbs water and forms solid waste.
Example sentence: *Most nutrient absorption happens in the small intestine.*

8. The Pancreas

Location: Behind the stomach.

Function: Produces digestive enzymes and the hormone insulin (controls blood sugar).
Example sentence: *Without the pancreas, a mammal cannot properly digest fats and proteins.*

9. The Spleen

Location: Left side of the abdomen, near the stomach.
Function: Filters blood, recycles old red blood cells, helps fight infection.
Example sentence: *The spleen acts as a blood reservoir for mammals during physical activity.*

10. The Skin

Location: Entire outer surface of the body.

Function: Protects against injury, infection, and water loss; helps regulate temperature. Example sentence: *A mammal's skin contains hair follicles, sweat glands, and nerve endings.*

11. The Reproductive Organs

Location: Lower abdomen / pelvic area.

Functions: Produce offspring.

Male mammals: Testes (produce sperm and testosterone).

Female mammals: Ovaries (produce eggs), uterus (where offspring develop). Example sentence: *In female mammals, the placenta forms in the uterus to nourish the growing baby.*

Summary

Organ Systems

System	Main Organs	Primary Job
Nervous	Brain, spinal cord, nerves	Control and communication
Circulatory	Heart, blood vessels	Transport oxygen and nutrients
Respiratory	Lungs, trachea	Gas exchange
Digestive	Stomach, intestines, liver, pancreas	Break down food, absorb nutrients

Excretory	Kidneys, bladder	Remove waste
Immune	Spleen, lymph nodes	Fight infection
Reproductive	Ovaries/testes, uterus	Produce offspring
Integumentary	Skin, hair, nails	Protection and temperature control

Questions

A. Multiple Choice (Choose the correct letter)

Which organ pumps blood through the body?
a) Liver
b) Heart
c) Kidney
d) Stomach

Oxygen enters the blood through which organ?
a) Skin
b) Brain
c) Lungs
d) Spleen

Which organ filters waste from the blood to make urine?
a) Pancreas
b) Large intestine
c) Kidney
d) Stomach

Where does a baby mammal develop before birth?
a) Ovary
b) Uterus

c) Testis
d) Liver

Which is the largest external organ in most mammals?
a) Liver
b) Heart
c) Skin
d) Small intestine

B. True or False (Write T or F)

___ The brain controls memory and thought.

___ The large intestine absorbs nutrients.

___ Mammals have only one kidney.

___ The pancreas produces insulin.

___ The spleen helps fight infection.

___ The stomach filters toxins from the blood.

C. Fill in the Blanks (Use the word bank)

Word Bank: *lungs, liver, skin, small intestine, brain, kidneys*

The _____ controls all body activities.

Oxygen and carbon dioxide are exchanged in the _____.

The _____ filters toxins from the blood.

Nutrients are absorbed in the _____.

The _____ protects the body from infection and water loss.

Waste is filtered from blood by the _____ to produce urine.

D. Match the Organ to Its Function

Draw a line or write the letter.

Organ	Function
1. Heart	A) Produces sperm
2. Pancreas	B) Absorbs water
3. Large intestine	C) Pumps blood
4. Testes	D) Produces digestive enzymes
5. Spleen	E) Recycles old red blood cells

E. Short Answer (Write 1–2 complete sentences)

What is the difference between the small intestine and the large intestine?

Why is the liver important for removing harmful substances?

Name two organs that work together in breathing.

What would happen to a mammal if its kidneys stopped working?

Why do female mammals need a uterus, but male mammals do not?

F. Label the Diagram (Descriptive)

Since no image is provided, write the organ name next to its description.

Located in the chest, pumps blood → _____

Located in the head, controls the body → _____

Located behind the stomach, makes insulin → _____

Two bean-shaped organs in the lower back → _____

The outer covering of the body → _____

G. Critical Thinking (Paragraph Answer)

Question:
A mammal is found to have trouble digesting food and controlling its blood sugar. Which two organs might not be working properly? Explain why.

5th Lesson

Introduction

Ruminants (suborder Ruminantia), including cattle, sheep, goats, deer, and giraffes, possess a digestive system uniquely adapted to exploit fibrous plant material, particularly cellulose and hemicellulose, which are recalcitrant to enzymatic digestion by monogastric animals. This evolutionary adaptation has allowed ruminants to occupy an ecological niche characterized by high-fiber, low-nutrient forages. The cornerstone of this system is a symbiotic relationship with a complex community of anaerobic microorganisms—bacteria, archaea, protozoa, and fungi—that colonize the forestomach.

2. Gross Anatomy of the Four Compartments

Unlike the simple stomach of monogastrics (e.g., humans, swine), the ruminant stomach is composed of four distinct compartments: the rumen, reticulum, omasum, and abomasum. The first three are derived from the esophagus and are non-glandular; the abomasum is the only glandular compartment, homologous to the monogastric stomach.

2.1 Rumen: The largest compartment (80-85% of total stomach volume in adult cattle, up to 150-200 liters). Its internal surface is lined with papillae (finger-like projections) that increase surface area for absorption of volatile fatty acids (VFAs). The rumen functions as a continuous-flow fermentation vat, maintained at 39–40°C and a near-neutral pH (5.5–7.0, ideally 6.0–6.5). Contents are stratified into a gas layer (CO_2, CH_4), a fibrous mat (long particles), a liquid phase, and a ventral sediment of dense particles.

2.2 Reticulum: Often described anatomically with the rumen (reticulorumen) due to continuous fluid exchange. Its internal mucosa has a honeycomb-like pattern. The reticulum is involved in particle sorting and the initiation of rumination. It also traps dense foreign objects (e.g., nails, wire), which can lead to hardware disease (traumatic reticuloperitonitis).

2.3 Omasum: A spherical organ with multiple muscular laminae (leaves) that grind digesta and absorb water, electrolytes, and some VFAs. It reduces particle size and prevents rapid passage of inadequately fermented material.

2.4 Abomasum: The "true stomach." Its glandular mucosa secretes hydrochloric acid (HCl; pH 2.0–3.0), pepsinogen (converted to pepsin), and rennin (chymosin,

important in young ruminants for curdling milk). Here, microbial cells from the rumen are lysed and their proteins are denatured and hydrolyzed.

3. The Process of Digestion: Step-by-Step

3.1 Ingestion and Salivation: Feed is rapidly ingested with minimal initial chewing. Saliva (up to 150–200 L/day in cattle) is produced continuously and contains bicarbonate (HCO_3^-), phosphate, and urea. Bicarbonate buffers the acidic VFAs produced during fermentation, while urea is recycled into the rumen as a nitrogen source for microbes.

3.2 Ruminal Fermentation: Upon entry, the digesta is mixed with the microbial population. Key reactions include:

- Cellulose hydrolysis: (catalyzed by cellulase, produced by *Fibrobacter succinogenes*, *Ruminococcus albus*, etc.)
- Glucose fermentation: (propionate) + 2 CO_2 + 2 H_2 or → CH_3COOH (acetate) + CO_2 + CH_4 (via methanogenic archaea)
- Major end products: Volatile fatty acids (acetate, propionate, butyrate in molar ratios of approximately 65:20:15 on high-forage diets), methane (CH_4), carbon dioxide, and heat.

3.3 Absorption and Metabolism: VFAs are absorbed across the rumen epithelium via passive diffusion (non-ionized form) and facilitated transport (ionized form). Acetate is used for adipose tissue lipogenesis; propionate is gluconeogenic (primary precursor for blood glucose); butyrate is metabolized to β-hydroxybutyrate by the rumen epithelium. Glucose is not absorbed from the rumen—it is immediately fermented.

3.4 Rumination and Eructation: Rumination is a cyclical process involving: (a) regurgitation of a bolus from the reticulorumen, (b) re-mastication (40–60 seconds), (c) re-salinization, and (d) re-swallowing. This reduces particle size to <1 mm, increasing microbial colonization surface area. Eructation (belching) releases accumulated fermentation gases (up to 30–50 L of CH_4 + CO_2 per hour in cattle); failure to eructate causes bloat (tympany).

3.5 Omasal and Abomasal Processing: Fluid and fine particles pass through the omasum, which absorbs 60-70% of remaining water. The abomasum then acidifies the digesta, denatures microbial protein, and initiates enzymatic proteolysis.

4. Microbial Protein and Post-Ruminal Digestion

A critical feature is that ruminants do not digest dietary protein directly in the foregut. Instead, dietary protein is degraded by microbes into ammonia (NH_3) and amino acids, which are then incorporated into microbial protein. This microbial biomass (approx. 0.5–1.0 kg/day in cattle) flows to the abomasum and small intestine, where it is digested and absorbed as a high-quality amino acid source, providing 50–80% of the animal's protein requirement.

In the small intestine (duodenum, jejunum, ileum), pancreatic enzymes (trypsin, chymotrypsin, amylase, lipase) and bile salts complete the digestion of microbial protein, residual starch, and lipids. Undigested fiber is fermented in the cecum and colon, though to a lesser extent than in the rumen.

5. Comparative Advantages and Environmental Impact

Advantages: Utilization of human-inedible cellulosic biomass; synthesis of essential amino acids from non-protein nitrogen (e.g., urea); production of high-quality animal protein (meat, milk, wool).

Disadvantages: Energy loss as methane (2–12% of gross energy intake); high water requirements; significant contribution to agricultural greenhouse gas emissions (enteric methane accounts for ~15–20% of total anthropogenic CH_4 globally).

Questions

Part A: Short Answer Comprehension (1-2 sentences each)

1. List the four compartments of the ruminant stomach in the order that digesta passes through them.
2. What is the primary ecological advantage of the ruminant digestive system over a monogastric system?
3. State the typical pH range in the rumen and explain why saliva is critical for maintaining it.
4. What are the three major volatile fatty acids (VFAs) produced by ruminal fermentation?
5. Explain the difference in function between the rumen and the abomasum.
6. Why is eructation (belching) essential for a ruminant's survival?
7. How do ruminants obtain glucose for metabolism, given that glucose is not absorbed from the rumen?
8. What is the source of "microbial protein," and why is it nutritionally important?

Part B: Vocabulary Matching (Match term a–j with definition 1–10)

Term		Definition
a. Cellulase	1.	The process of regurgitating, re-chewing, and re-swallowing feed.
b. Reticulum	2.	An enzyme that hydrolyzes β-1,4 glycosidic bonds in cellulose.
c. Papillae	3.	The "true stomach" that secretes HCl and pepsinogen.
d. Abomasum	4.	Finger-like projections in the rumen that increase absorptive surface area.
e. Methanogens	5.	The compartment that sorts particles and traps foreign objects.
f. Tympani (bloat)	6.	Volatile fatty acids; primary energy source from fermentation.
g. Eructation	7.	The release of accumulated ruminal gases via the esophagus.
h. Rumination	8.	Archaea that produce methane as a metabolic byproduct.

i. VFAs	9.	A potentially fatal condition caused by failure to eructate.
j. Omasum	10.	The compartment with many muscular leaves that absorbs water.

Part C: Data Interpretation and Calculations

Use the information from the text to answer the following.

1. A dairy cow produces 200 L of saliva per day, and each liter contains 140 mmol of bicarbonate (HCO_3^-). Calculate the total moles of bicarbonate secreted daily. If each mole of bicarbonate neutralizes 1 mole of VFA, how many moles of VFA can this buffer neutralize?

2. In a typical high-forage diet, the molar ratio of acetate:propionate:butyrate is 65:20:15. If a cow produces 30 moles of total VFA per day, calculate the daily production of propionate in moles.

3. The text states that enteric methane accounts for 15-20% of global anthropogenic methane. If total anthropogenic methane emissions are 360 million metric tons per year, what is the range (lower and upper bound) of enteric methane from ruminants in million metric tons?

Part D: Critical Thinking and Essay-Style Questions (Paragraph answers)

1. Explain why ruminants cannot directly absorb glucose from dietary cellulose, despite cellulose being a glucose polymer. Use your knowledge of microbial fermentation and rumen physiology.
2. Compare and contrast the abomasum of a mature ruminant with the stomach of a monogastric animal (e.g., human or pig). Identify at least two similarities and two differences in structure and function.
3. Discuss a potential nutritional strategy to reduce enteric methane emissions from ruminants, based on the information provided about fermentation end-products. (Hint: Consider shifting the acetate:propionate ratio.)
4. Synthesize information from the text to explain why urea (a non-protein nitrogen source) can be added to cattle feed to replace

some dietary protein, whereas it would be useless or toxic in a monogastric diet.

Answer Key

Part A

1. Rumen → Reticulum → Omasum → Abomasum.
2. It allows digestion of fibrous cellulose via microbial fermentation, enabling ruminants to utilize human-inedible forages.
3. pH 5.5–7.0 (ideal 6.0–6.5). Saliva provides bicarbonate and phosphate buffers that neutralize VFAs produced during fermentation.
4. Acetate, propionate, butyrate.
5. The rumen is a non-glandular fermentation vat (neutral pH) for microbial digestion of fiber; the abomasum is a glandular true stomach (acidic pH) for enzymatic protein digestion.
6. Eructation releases accumulated fermentation gases (CO_2, CH_4); without it, the rumen distends with gas, causing bloat (tympany) which can be fatal.
7. Glucose is produced via gluconeogenesis, primarily from propionate absorbed from the rumen.
8. Microbial protein is synthesized by rumen microbes from ammonia and dietary amino acids. It provides 50-80% of the ruminant's absorbable amino acids in the small intestine.

Part B

a-2, b-5, c-4, d-3, e-8, f-9, g-7, h-1, i-6, j-10

Part C

11. 200 L/day × 0.140 mol/L = 28 mol HCO_3^-/day. That neutralizes 28 mol VFA/day.
12. 30 mol VFA/day × (20/100) = 6 mol propionate/day.
13. Lower bound: 360 × 0.15 = 54 million metric tons. Upper bound: 360 × 0.20 = 72 million metric tons.

Part D (Sample key points)

1. Cellulose is hydrolyzed to glucose by microbial cellulases, but the glucose is immediately taken up and fermented by the same microbes into VFAs. The rumen epithelium lacks glucose transporters for luminal

glucose; instead, it is adapted to absorb VFAs. The animal then synthesizes glucose via gluconeogenesis from propionate.

2. Similarities: both secrete HCl and pepsinogen; both have glandular mucosa. Differences: the abomasum receives microbial protein (not dietary protein directly); the abomasum is the last compartment (not first); in ruminants, the abomasum functions after extensive microbial pretreatment.

3. Methane is produced from H_2 and CO_2 via methanogens. Propionate production consumes H_2 ($2H_2 + CO_2 \rightarrow CH_3COO^- + H^+$?), actually propionate is a hydrogen sink. Feeding ionophores (e.g., monensin) or dietary lipids can shift fermentation toward propionate and away from acetate + methane, reducing CH_4 emissions by 10–30%.

4. Rumen microbes have urease enzyme and can hydrolyze urea to NH_3, which they then use to synthesize microbial protein. In monogastrics, urea is rapidly absorbed into blood and can cause hyperammonemia (toxicity). Ruminants can safely use urea because the rumen acts as a "fermentation vat" that captures NH_3 before it reaches the liver.