Monogastric Digestive System – Study Answers

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1. Secretions of the GI Tract (Enzymes, Substrates, Products)

Organ/Gland	Secretion/Enzyme	Substrate	Product	Role/Function
Salivary glands	Salivary amylase (in pigs)	Starch	Maltose	Starts carbohydrate digestion
	Mucus	N/A	Lubricates food	Aids swallowing & protect tract
Stomach - Chief Cells	Pepsinogen (inactive)	Proteins	Peptides	Protein digestion (activated by HCl
	Rennin / chymosin	Milk proteins (casein)	Coagulated milk	Breaks down milk molecules
Stomach – Parietal cells	HCl	N/A	Acidic environment	Activates pepsinogen, kills microbes
	Intrinsic factor	N/A	Binds vitamin B12	Absorption of B12 in small intestine
Stomach – Mucous cells	Mucus	N/A	Protective barrier	Protects stomach lining
Small intestine – Brush border enzymes	Maltase	Maltose	Glucose	Final carbohydrate digestion

	Sucrase	Sucrose	Glucose + Fructose	Digests table sugar
	Lactase	Lactose	Glucose + Galactose	Digests milk sugar
Pancreas – Exocrine	Amylase	Starch	Maltose	Carbohydrate digestion
	Lipase	Lipids (triglycerides)	Fatty acids + glycerol	Fat digestion
	Trypsin / chymotrypsin	Proteins	Peptides	Protein digestion
	Bicarbonate	N/A	Neutralizes acidic chyme	Protects small intestine
Liver / Gallbladder	Bile / bile salts	Lipids	Emulsified fats	Fat digestion and absorption

2. Function / Role of the GI Tract

- **Prepare food for absorption** through mechanical and chemical digestion.
- **Mechanical digestion:** reduces particle size for increased surface area.
- **Chemical digestion:** enzymes break down macromolecules into absorbable nutrients.
- **Absorption:** nutrients are absorbed mainly in the small intestine into **blood (carbs, amino acids)** or **lymph (lipids)**.

3. Prehension

- **Definition:** The act of getting food into the mouth.
- **Prehensile tools by species:**
    - **Pig:** Snout

- **Cow / Ruminants:** Tongue and lips
- **Horse:** Lips and teeth
- **Bird:** Beak / tongue

4. Mastication

- **Definition:** Chewing of food.
- **Role:**
  - Reduces particle size
  - Mixes food with saliva
  - Prepares food for enzymatic digestion

5. Salivary Enzymes & Species

- **Pigs:** Have salivary amylase → begins carbohydrate digestion
- **Horses, ruminants, birds:** No salivary enzymes (saliva mainly lubricates)

6. Functions of the 4 Teeth Types (Monogastrics like pigs)

Tooth Type	Function
Incisors	Cutting / biting food
Canines	Tearing food
Premolars	Grinding and chewing
Molars	Grinding, crushing food to reduce size

7. Salivary Glands (Parts, Secretions, Functions)

Gland	Secretion	Function
Parotid	Serous (watery)	Lubricates, contains enzymes (amylase in pigs)
Submaxillary	Mucus + serous	Lubricates, enzyme activity
Sublingual	Mucus	Lubrication, aids swallowing

Saliva function: lubrication, protects oral cavity, moistens food, starts starch digestion (pigs only).

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8. Esophagus

- **Role:** Hollow, muscular tube that transports food to the stomach via **peristalsis**.
- **Species note:** Most monogastrics can't vomit easily (horses = one-way tube).

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9. Stomach Anatomy & Secretions

- **Regions:**
    1. **Cardia:** Entry of esophagus; secretes mucus
    2. **Fundus / Body:** Parietal cells (HCl, intrinsic factor), Chief cells (pepsinogen)
    3. **Pylorus:** Secretes mucus; regulates chyme passage
    4. **Antrum:** Mixing and grinding
- **Cell Types:** Parietal, Chief, Mucus Neck, G cells (gastrin hormone)
- **Folds / Gastric glands:** Increase surface area for secretion; pit glands secrete acid, enzymes, mucus.

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10. Small Intestine

- **Parts:** Duodenum, Jejunum, Ileum
- **Secretions:** Brush border enzymes (maltase, sucrase, lactase), mucus
- **Accessory organs:** Pancreas (enzymes + bicarbonate), liver/gallbladder (bile)
- **Villi & microvilli:** Increase surface area → maximize absorption
- **Cell types & functions:**
    - Enterocytes: absorb nutrients
    - Goblet cells: secrete mucus
    - Enteroendocrine cells: secrete hormones regulating digestion
- **Absorption routes:**
    - Carbohydrates & amino acids → blood (portal system)
    - Lipids → lymph (thoracic duct → circulation)

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11. Large Intestine

- **Parts:** Cecum (ileocecal valve), colon, rectum
- **Functions:**
    - Water absorption
    - Bacterial fermentation (cecum in pigs) → some B-vitamin & vitamin K synthesis
    - Feces formation

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12. Avian GI Tract

- **Prehensile tools:** Beak & tongue
- **Esophagus & Crop:** Moistening and storage, limited enzymatic breakdown
- **Proventriculus:** Chemical digestion, acid and enzymes
- **Gizzard / Ventriculus:** Mechanical digestion, grinding
- **Small intestine:** Absorption, brush border enzymes
- **Ceca:** Microbial fermentation, water absorption
- **Cloaca:** Excretion of digestive & urinary products
- **Classification:** Modified monogastric (shorter GI tract, faster passage, less fermentation than swine)

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13. Poultry vs Swine GI Tract Comparison

Feature	Poultry	Swine
GI length	Shorter	Longer
Rate of passage	Faster	Slower
Large intestine capacity	Smaller	Larger
Microbial fermentation	Limited	More significant in cecum
Digestive strategy	Proventriculus + gizzard	Stomach (acid + enzymes)

Ruminant Digestive System – Study Answers

1. GI Tract Secretions in Ruminants

Ruminants produce secretions throughout their GI tract that aid in digestion. Key secretions include:

Secretion	Source	Enzyme / Function	Substrate	Product
Saliva	Salivary glands	- No major digestive enzymes, but **contains bicarbonate & phosphate buffers**	-	Buffers rumen pH, moistens feed, aids in chewing
Rumen Microbial Secretions	Microbes in rumen	Various **enzymes: cellulase, hemicellulase, amylase, protease**	Cellulose, hemicellulose, starch, proteins	Volatile fatty acids (VFAs), microbial protein, gases (CO_2, CH_4)
Gastric Secretions (abomasum)	Abomasum (true stomach)	Pepsin, rennin	Protein	Peptides, amino acids
Pancreatic Secretions	Pancreas	Amylase, lipase, trypsin, chymotrypsin	Starch, fats, proteins	Glucose, fatty acids, amino acids
Bile	Liver / gallbladder	No enzymes; bile salts emulsify fat	Fat	Micelles for fat absorption
Intestinal Secretions	Small intestine	Maltase, lactase, sucrase, peptidases	Disaccharides, peptides	Monosaccharides, amino acids

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2. Importance of Bicarbonate

- Secreted in **saliva**.
- **Function:** Neutralizes acids in the rumen to maintain optimal pH (~6-7) for microbial fermentation.
- Without bicarbonate, microbial activity drops, leading to **acidosis**.

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3. Ruminant vs. Hindgut Fermenter GI Tract

Ruminants (cows, sheep, goats): **Foregut fermenters**

- Large **rumen** for microbial fermentation before the small intestine.
- Microbes break down cellulose into VFAs, proteins, and vitamins.
- Allows **microbial protein** to be digested later in the abomasum.

Hindgut Fermenters (horses, rabbits):

- Fermentation occurs **after the small intestine** (cecum & colon).
- Microbial protein mostly **lost** in feces; vitamins and VFAs absorbed.
- Faster digestion of starches but less efficient use of fiber.

Key Differences:

Feature	Ruminant	Hindgut Fermenter
Fermentation site	Rumen (foregut)	Cecum & colon (hindgut)
Microbial protein use	Digested in abomasum	Mostly lost
Fiber efficiency	High	Moderate
Speed of feed passage	Slower	Faster

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4. Foregut vs Hindgut in Ruminants

Foregut:

- Rumen
- Reticulum
- Omasum
- Abomasum

Hindgut:

- Small intestine (duodenum, jejunum, ileum)
- Cecum
- Large colon/Intestine
- Small colon
- Rectum

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5. Special Features of the Equine GI Tract

- **Monogastric with hindgut fermentation**.
- **Cecum** is the primary fermentation site (like a large rumen in function).
- Fiber is fermented **after the small intestine**, so microbial protein is **not absorbed** efficiently.
- Horses require **frequent grazing** for optimal VFA production.

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6. Rumination

Definition: Re-chewing, re-salivating, and re-swallowing ingested feed.

Function:

1. Reduces particle size for easier microbial digestion.
2. Increases saliva production → more **bicarbonate** → stabilizes rumen pH.
3. Improves fermentation efficiency.

Process:

1. Regurgitation → 2. Re-chewing → 3. Re-salivation → 4. Re-swallowing

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7. Importance of Ruminant Saliva

- Contains **bicarbonate & phosphate buffers** → maintains rumen pH.
- Moistens feed → easier to form cud.
- Provides **minerals** (Na^+, K^+) for microbial growth.
- Can produce **10-30 liters/day** in cows!

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8. Hardware Disease

- Occurs in the **reticulum**.
- Caused by ingestion of **sharp metal objects** (nails, wire).
- Can puncture the **reticulum wall**, causing **peritonitis**.
- Often treated with a **rumen magnet** to prevent damage.

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9. Rumen Favorable Conditions for Microbes

- **Constant temperature 102 F**
- Constant pH (5.5-7.0) buffered by bicarbonate
- Motility- Mixing of digesta
- End products removed- no accumulation of end products
- No humoral defense mechanisms
- Continuous nutrient supply

NEGATIVE ASPECTS

No oxygen- anaerobic

Feed May be limiting

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10. Types of Rumen Microbes

Type	Role	Products
Bacteria	Cellulose, starch, protein digestion	VFAs, ammonia, microbial protein

Protozoa	Phagocytize bacteria, fiber breakdown	VFAs, microbial protein
Fungi	Penetrate tough fibers	VFAs
Archaea	Methane production	CH_4

Products of Fermentation:

- **VFAs:** Acetate (fat synthesis), Propionate (glucose precursor), Butyrate (energy)
- **Microbial protein:** Digested in abomasum → amino acids
- **Gases:** CO_2 and CH_4 (eructation necessary)

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11. Common Ruminant Problems

- **Bloat:** Gas accumulation in rumen → pressure → respiratory distress.
- **Acidosis:** Excess grain → low pH → microbial death.
- **Hardware disease:** As above, puncture of reticulum wall.
- **Parasitism:** Worms affect nutrient absorption.
- **Diarrhea / scours:** Microbial imbalance or dietary change.
