Nutrition of pigs, poultry and rabbits

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Nutrition of pigs

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Digestive anatomy and physiology of pigs

- The mouth of the pig
  - Long and varies with breed
  - Birth piglets have
    - Eight deciduous teeth
    - Four incisors teeth
    - Four canines teeth
  - Adult pigs have
    - 44 teeth
      - Complete by 18 months of age
    - Canines in boars continue to grow throughout life

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Digestive anatomy and physiology of pigs

- Salivary glands
  - Saliva is a mixture of
    - Water
      - Electrolytes
      - Mucus
      - Enzymes
        - α-amylase
        - Lysozyme
      - Immunoglobulin-A
- Role of saliva
  - Lubricate the food
  - Begin starch digestion to glucose
  - Protect against disease
  - Recycle electrolytes to the intestines
- Volume and composition of saliva varies
  - Dry feeds or a high feed intake
    - High volume of saliva secretion

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Digestive anatomy and physiology of pigs

- Gastrointestinal tract

Segment	Length (absolute)	Capacity (absolute)	Capacity (relative)
	(metres)	(litres)	(%)
Stomach		8	29
Small intestine	18.3	9.2	33
Caecum	0.2	1.55	6
Colon and rectum	5.0	8.70	32

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Digestive anatomy and physiology of pigs

- Gastrointestinal tract
  - Stomach
    - Simple, gastric stomach
    - Relatively larger than that of other mono-gastrics
    - Oesophagus enters the stomach at the cardia

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Digestive anatomy and physiology of pigs

- Gastrointestinal tract
  - Stomach
    - Glandular epithelia
      - Cardiac gland region
        - » Produces a large amounts of mucus
      - Gastric gland region and pyloric gland region
        - » Producing
        - » Gastric acid
        - » Pepsin

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Digestive anatomy and physiology of pigs

- Gastrointestinal tract
  - The small and large intestines
    - Stomach empties into the duodenum through the pyloric sphincter
    - Small intestines comprise
      - Duodenum, jejunum and ileum
      - 16–21 m long in the adult pig
    - Large intestines comprise
      - Caecum and a colon

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Digestive anatomy and physiology of pigs

- Gastrointestinal tract
  - The small and large intestines
    - Small intestine
      - 80% of the length of the entire gut
      - Capacity almost 10 L
      - Relative lengths of the small intestine segments
        - » Duodenum
          - 5%
        - » Jejunum
          - 90%
        - » Ileum
          - 5%

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Nutritional requirements of pigs

- Pigs require
  - Number of essential nutrients to
    - Growth
    - Reproduction
    - Lactation
    - Other functions
  - Factors increase the needed level of nutrients
    - Genetic variation
    - Environment
    - Availability of nutrients in feedstuffs
    - Disease levels
    - Stressors

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Nutritional requirements of pigs

- Factors
  - Growth rate
  - Gender
  - Energy of diet
  - Environmental temperature
  - Crowding
  - Parity
  - Stage of gestation
- Estimating
  - Nutrient requirements
  - Nutritionists
  - Feed manufacturers

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Nutritional requirements of pigs

- General classes of nutrients
  - Water
  - Carbohydrates
  - Fats
  - Protein
    - Amino acids
  - Minerals
  - Vitamins
- Energy
  - Derived from oxidation of carbohydrates and fats
- Amino acids
  - From protein
  - Maintenance and tissue protein synthesis

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Nutritional requirements of pigs

- Other feed additives
  - Antibiotics
  - Chemotherapeutic agents
  - Microbial supplements
    - Prebiotics
    - Probiotics
  - Enzymes

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Nutritional requirements of pigs

- Energy
  - Energy requirements
    - Kilocalories (kcal) of
      - Digestible energy
      - Metabolizable energy
      - Net energy
    - Most commonly used
      - Digestible energy
      - Metabolizable energy
    - Trend in industry to formulate diets
      - Net energy

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Nutritional requirements of pigs

- Energy
  - Requirements are influenced
    - Weight
    - Genetic capacity for
      - Lean tissue growth
      - Milk production
    - Environmental temperature

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Nutritional requirements of pigs

- Protein and amino acids
  - Required for
    - Maintenance
    - Muscle growth
    - Development of fetuses
    - Supporting tissues in gestating sows
    - Milk production in lactating sows

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Nutritional requirements of pigs

- Amino acids
  - 12 amino acids are synthesized
  - 10 amino acids must be provided in diet for normal growth
    - Arginine
    - Histidine
    - Isoleucine
    - Leucine
    - Lysine
    - Methionine
    - Phenylalanine
    - Threonine
    - Tryptophan
    - Valine

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Nutritional requirements of pigs

- Amino acids
  - Greatest practical importance in diet
    - Lysine
    - Tryptophan
    - Threonine
    - Methionine
  - Corn
    - Deficient in
      - Lysine
      - Tryptophan
  - Grains (barley, and wheat)
    - Deficient in
      - Lysine
      - Threonine
  - Soybean meal
    - Deficient in
    - Methionine

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Nutritional requirements of pigs

- Protein
  - Milk protein
    - Well balanced in essential amino acids
  - Dried whey
    - Protein with an excellent profile of amino acids
      - Total protein content is low
  - Animal proteins
    - Good sources of
      - Minerals
      - B-complex vitamins

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Nutritional requirements of pigs

- Protein and amino acids
  - Diets for early weaned pigs
    - High levels of
      - Dried animal plasma
      - Dried blood cells
    - Deficient in methionine
    - High levels of methionine
      - Depress growth

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Nutritional requirements of pigs

- Protein and amino acids
  - Lysine
    - First limiting amino acid

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Nutritional diseases of pigs

- Diagnosis is difficult
- Clinical signs are result of
  - Mismanagement
  - Infectious diseases
    - Parasitism
    - Malnutrition
- Nutritional deficiencies
  - Poor appetite
  - Reduced growth
  - Unthriftiness
  - Difficult diagnosis

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Nutritional diseases of pigs

- Nutritional therapy is not always clear
- Longterm deficiencies
  - Lesions may be irreversible
- Diagnosed positively
  - Clinical signs
  - Review of
    - Dietary history of the animals
    - Disease history of the animals
    - Management history of the animals

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Nutritional diseases of pigs

- Protein deficiency
  - Result from
    - Suboptimal feed intake or deficiency of
      - one or more essential amino acids
  - Causes
    - Reduced gains
    - Poor feed conversion
    - Fatter carcasses in
      - Growing pigs
      - Finishing pigs
  - Lactating sows
    - Milk production is reduced
    - Excess weight loss
    - Postweaning estrus
    - Delayed return to estrus

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Nutritional diseases of pigs

- Protein deficiency
  - Diets containing much protein
    - Laxative
    - Less efficiently

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Nutritional diseases of pigs

- Fat deficiency
  - Long-chain polyunsaturated fatty acids
    - Essential for swine
  - Linoleic acid
    - Essential
    - Used to produce longer-chain fatty acids
    - Deficiency
      - Hair loss
      - Scaly dermatitis
      - Skin necrosis on the neck and shoulders
      - Unthrifty appearance in growing pigs

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Nutritional diseases of pigs

- Mineral deficiency
  - Calcium or phosphorus
    - Rickets
      - Growing pigs
    - Osteomalacia
      - Mature pigs
    - Signs
      - Deformity and bending of long bones
      - Young pigs
        - » Lameness
      - Older pigs
        - » Fractures and posterior paralysis
      - Sows
        - » Posterior paralysis
          - End of lactation
          - After weaning

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Nutritional diseases of pigs

- Mineral deficiency
  - Iron and copper
    - Reduce
      - Rate of hemoglobin formation
      - Nutritional anemia
    - Signs
      - Suckling pigs
        - » Low hemoblogin and red blood cell
        - » Pale mucous membranes
        - » Enlarged heart
        - » Skin edema about the neck and shoulders
        - » Listlessness
        - » Spastic breathing

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Nutritional diseases of pigs

- Mineral deficiency
  - Zinc
    - Growing pigs
      - Parakeratosis
    - Diets
      - High in phytic acid
      - More than recommended amount of calcium

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Nutritional diseases of pigs

- Mineral deficiency
  - Selenium and vitamin E
    - Young pigs
      - Sudden death
      - More susceptible to iron toxicosis

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Nutritional diseases of pigs

- Vitamin deficiency
  - vitamin A
    - Disturbances
      - Of eyes
      - Epithelial tissues
        - » Respiratory systems
        - » Reproductive systems
        - » Nervous systems
        - » Urinary systems
        - » Digestive systems
    - Sows
      - Eyeless
      - Weak

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Nutritional diseases of pigs

- Vitamin deficiency
  - Vitamin D
    - Signs
      - Rickets
      - Stiffness
      - Weak and bent bones
      - Posterior paralysis

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Nutritional diseases of pigs

- Vitamin deficiency
  - Vitamin E
    - Poor reproduction
    - Impaired immune system

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Nutritional diseases of pigs

- Vitamin deficiency
  - Biotin
    - Excessive hair loss
    - Skin ulcerations
    - Dermatitis
    - Exudates around eyes

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Nutritional diseases of pigs

- Vitamin deficiency
  - Vitamin B_{12}
    - Neonatal pigs
      - Hyperirritability
      - Voice failure
      - Pain and incoordination in the hindquarters

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Nutritional requirements of pigs

- Water
  - Free and convenient access to water
  - Amount required
    - Age
    - Type of feed
    - Environmental temperature
    - Status of lactation
    - Fever
    - High urinary output
    - Diarrhea
  - Normally
    - 2–3 kg of water for every kg of dry feed
  - Lactating sows
    - Consume more
      - High water content of milk

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Nutritional requirements of pigs

- Water
  - Quality
    - Free of microbial contamination
    - Minerals
      - May create problems
        - » 7,000 ppm are unfit

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Nutrition of poultry

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Digestive anatomy and physiology of chickens

- Mono-gastric animal
- Simple but efficient digestive system
- Intestinal digestion of high-quality feeds

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Digestive anatomy and physiology of chickens

- Digestive tract comprises
  - Oesophagus
    - Pre-crop
    - Post-crop
  - Crop
  - Proventriculus
  - Gizzard
  - Small intestine
    - Duodenum
    - Jejunum
    - Ileum
  - Large intestine
    - Caeca (paired)
    - Colon
    - Cloaca

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Digestive anatomy and physiology of chickens

- Mouth
  - Beak
    - Keratinised structure
    - Overlying the mandibles and incisive bones
    - There are no teeth

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Digestive anatomy and physiology of chickens

- Crop
  - Used in grain-eating birds
  - Store food
  - Storage function
    - Allows birds to eat ‘meals’
    - ontinually digest food
  - Fermentation
    - Minor contributor to total energy production

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Digestive anatomy and physiology of chickens

- Proventriculus (glandular stomach)
  - Dilation of gut
  - Contains pepsin and hydrochloric acid
    - Beginning of protein digestion

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Digestive anatomy and physiology of chickens

- Gizzard (ventriculus)
  - Thick, muscular gizzard
  - Rounded organ
    - Covered on the serosal side by connective tissue
      - Circular and longitudinal muscles
        - » Thick
        - » Produce strong grinding motions
  - Grit
    - Acts as a grinding agent akin to teeth in mammals

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Digestive anatomy and physiology of chickens

- Small intestines
  - Digesta enters the duodenal loop
    - Centre of pankreas
    - Pancreatic secretions include
      - Proteases
      - Lipases
      - Polysaccharidases
      - Bicarbonate
        - » Neutralises pH of the chyme
  - Aktivity
    - Breaks down
      - Proteins and peptides into amino acids
      - Polysaccharides into simple sugars
      - Lipids into fatty acids
    - Absorbed
      - Minerals
      - Vitamins

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Digestive anatomy and physiology of chickens

- Large intestines
  - Two blind caeca
    - 16–18 cm in length
  - Fermentation

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Digestive anatomy and physiology of chickens

- Colon
  - Short
  - Ends at cloaca
- Urodeum
  - Area in the caudal large intestine
  - Contains distal openings of ureters from kidneys
  - Uric acid => Deposited with faeces

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Nutritional requirements of poultry

- Poultry convert feed
  - Quickly
  - Efficiently
  - Relatively low environmental impact
- High rate of productivity
  - High nutrient needs
- Criteria to determine the requirement include
  - Growth
  - Feed efficiency
  - Egg production

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Nutritional requirements of poultry

- Changes in feed intake
  - Environmental temperature
  - Dietary energy content
  - Genetic strain
  - Husbandry conditions
    - Sanitation
  - Presence of stressors
    - Diseases
    - Mycotoxins

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Nutritional requirements of poultry

- Amino acids
  - Poultry synthesize
    - Proteins that contain 20 L-amino acids
  - Unable to synthesize
    - Arginine
    - Isoleucine
    - Leucine
    - Lysine
    - Methionine
    - Phenylalanine
    - Threonine
    - Tryptophan
    - Valine

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Nutritional requirements of poultry

- Amino acids
  - Can synthesized but dietary source is required
    - Histidine
    - Glycine
    - Proline
  - Tyrosine and cysteine
    - Can be synthesized from
      - Phenylalanine
      - Methionine

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Nutritional requirements of poultry

- Vitamins
  - Vitamin A
    - Young chicks
      - Use less efficiently
  - Vitamin D
    - Cholecalciferol
      - Vitamin D_3
    - Ergocalciferol
      - Vitamin D_2
      - Used with an efficiency of vitamin D_3

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Nutritional requirements of poultry

- Vitamins
  - Vitamin E
    - Antioxidant
      - Diets with high in long-chain highly polyunsaturated fatty acids
  - Choline
    - Part of
      - Phospholipid
      - Acetylcholine
    - Source of methyl groups
    - Betaine
      - Requirement for choline
      - Cannot completely replace in diet

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Nutritional requirements of poultry

- Vitamins
  - Are subject to degradation over time
    - Accelerated by
      - Moisture
      - Oxygen
      - Trace minerals
      - Heat
      - Light

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Nutritional requirements of poultry

- Minerals
  - Much of phosphorus
    - Is not absorbed efficiently
  - Calcium
    - Laying hens
      - Increases with rate of
      - Egg production
      - Age of hen
  - Ratio of
  - Calcium : Phosphorus
  - 2:1

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Nutritional requirements of poultry

- Other nutrients and additives
  - Necessary for growth
    - Vitamin C
    - Pyrroloquinoline quinone
    - Several heavy metals
  - Non-nutrient antioxidants
    - Ethoxyquin
      - Protect
        - » Vitamins
        - » Unsaturated fatty acids
  - Enzymes

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Nutritional deficiencies

- Difficult to diagnose
- Signs
  - Affected living birds
  - Necropsies
  - Tissue analyses
- Stress may interfere with
  - Absorption nutrient
  - Increase quantity
  - Stress
    - Infections
      - Bacterial
      - Parasitic
      - Viral
    - High or low temperatures

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Protein, amino acid, and energy deficiencies

- Protein, amino acid low
  - Slowly grow
- Deficiency of various amino acids
  - Signs
    - Peculiar
    - Loss of pigment
    - Retarded growth
    - Reduced egg size or egg production

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Protein, amino acid, and energy deficiencies

- Deficiency of energy
  - Bird will
    - Grow slowly
    - Stop ovulating
  - Ketosis

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Vitamin deficiencies

- Inadvertent omission of vitamin premix
- Signs
  - Vitamin B
    - Appear first
  - vitamin A
    - Months
- Vitamin destruction factor
  - Time
  - Temperature
  - Humidity

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Vitamin deficiencies

- Vitamin A
  - Egg production drop
  - Hatchability decreases
  - Embryonic mortality increases

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Vitamin deficiencies

- Vitamin D_3
  - Required for absorption and metabolism of
    - Calcium
    - Phosphorus
  - Deficiency
    - Rickets
    - Osteoporosis
    - Poor eggshell quality

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Vitamin deficiencies

- Vitamin B_{12}
  - Essential of
    - Enzyme systems
      - Transfer or synthesis methyl groups
    - Metabolism of
      - Nucleic acids
        - » Proteins
    - Functions
      - Carbohydrate
      - Fat metabolism

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Vitamin deficiencies

- Vitamin B_{12}
  - Signs
    - Growing chickens
      - Reduced
        - » Weight gain
        - » Feed intake
      - Poor feathering
      - Nervous disorders
    - Anemia
    - Gizzard erosion

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Mineral deficiencies

- Calcium and phosphorus
  - Lack of normal skeletal calcification
  - Rickets
  - Reduced shell quality
  - Osteoporosis

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Mineral deficiencies

- Iron and copper
  - Anemia
  - Loss of pigmentation in feathers
  - Aflatoxin reduces iron absorption

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Mineral deficiencies

- Zinc
  - Young chicks
    - Retarded growth
    - Shortening leg bones
    - Thickening leg bones
    - Enlargement hock joint
    - Poor feathering
    - Loss of appetite
    - Mortality
  - Hens
    - Reduce egg production
  - Hatched chicks
    - Weak
    - Cannot
      - Stand
      - Eat
      - Drink
    - Accelerated respiratory rates

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Nutritional requirements of poultry

- Water
  - Essential nutrient
  - Factors influence water intake
    - Environmental temperature
    - Relative humidity
    - Diet
      - Salt level
      - Protein level
    - Birds' productivity
      - Growth
      - Egg production

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Nutritional requirements of poultry

- Water
  - Cool
  - Clean
  - Uncontaminated by
    - Minerals
    - Potential toxic substances

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Nutritional requirements of poultry

- Water
  - Requirements
    - Highly variable
  - Deprivation for
    - ≥12 hours
      - » Adverse on
        - Growth
        - Egg production
    - ≥36 hours
      - » Increase in mortality

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Nutrition of rabbits

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Anatomy and functions of the rabbit digestive tract

- Rabbits masticate their feed very thoroughly
  - As many as 120 jaw movements per minute
  - Ingested material is broken down to small particle sizes
- Stomach
  - Thin-walled
  - Pouchlike
  - pH in the adult
    - From 1 to 2
      - Kills bacteria and other microorganisms
        - » Stomach and small intestine are essentially sterile

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Anatomy and functions of the rabbit digestive tract

- Stomach
  - Secretions
    - Hydro chloric acid
    - Digestive enzymes
      - Pepsin (secreted as pepsinogen)
      - Mucus
  - Storage organ
    - Metering ingesta into the small intestine
    - Never completely empty

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Anatomy and functions of the rabbit digestive tract

- Stomach
  - High acidity => Some fermentation occurs

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Anatomy and functions of the rabbit digestive tract

- Small intestine
  - Major site of
    - Digestion
    - Absorption
  - Divided into three functional areas
    - Duodenum
    - Jejunum
    - Ileum
  - Duodenum
    - Neutralization of the acid material coming from the stomach
    - Mixing by muscular churning action

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Anatomy and functions of the rabbit digestive tract

- Small intestine
  - Pancreas
    - Source of major digestive enzymes
      - Carbohydrate digestion
      - Protein digestion
      - Fat digestion
    - Alkaline secretions
      - Neutralize stomach acid

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Anatomy and functions of the rabbit digestive tract

- The hindgut
  - Fermentation in the cecum
  - Selective excretion of fiber
  - Coprophagy
    - Reingestion of cecal contents

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Anatomy and functions of the rabbit digestive tract

- The hindgut
  - Appendix
    - Secretes an alkaline fluid
    - Buffer the volatile fatty acids produced during cecal fermentation
    - Lymphoid organ
    - Have an influence on microbial fermentation

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Anatomy and functions of the rabbit digestive tract

- The hindgut
  - Coprophagy or cecotrophy
    - Consumption of the cecal contents
    - Composition of soft feces, cecal contents, and hard feces suggests that the soft feces (cecotropes) are of cecal origin
    - Soft feces
      - Surrounded by a mucilaginous membrane
      - Cecotropes
        - » Are consumed as discrete clusters
        - » Continue to ferment in stomach

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Anatomy and functions of the rabbit digestive tract

- The hindgut
  - Cecotrophy
    - Integral part of a rabbit's digestive physiology
    - Necessary for maximum digestibility of
      - High-fiber (low-energy) diets
      - Low-fiber (high energy) diets
      - Important in efficient digestion of protein
      - Cecotropes are rich in B vitamins

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Anatomy and functions of the rabbit digestive tract

- The hindgut
  - Excretion of
    - Hard feces
      - During first 4 hour after feeding
    - Soft feces
      - Rabbit licking anal area => Consuming the cecotropes

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Anatomy and functions of the rabbit digestive tract

- The hindgut
  - The composition of hard and soft feces
    - Influenced by diet
  - Low dietary protein
    - Less effect on reducing protein content
  - Hypomotility of hindgut
    - Diarrhea
    - Cecal impaction

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Nutritional requirements of rabbits

- Rabbits
  - Small herbivores
  - Specialized
    - Feeding needs
    - Digestive systems
  - Selective eaters
  - Naturally pick and choose foods higher in energy density
    - Predisposes to obesity

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Nutritional requirements of rabbits

- Bacterial population in cecum
  - Gram-positive Bacteroides sp.
  - Very sensitive to oral antibiotics

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Nutritional requirements of rabbits

- Fiber
  - Digest fiber poorly
    - Selective separation and rapid excretion of large particles in the hindgut
  - High-fiber intake
    - Ad lib timothy hay
  - Absorb bacterial toxins
    - Eliminate them via hard feces
  - Diets low in fiber
    - Increased incidence of intestinal problems
      - Enterotoxemia

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Nutritional requirements of rabbits

- Fiber
  - Indigestible fiber
    - Important for stimulating gastrointestinal tract motility
    - Preventing behavioral problems
      - Fur chewing
    - Providing dental wearing
    - Stimulating
      - Appetite
      - Ingestion of cecotrophs

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Nutritional requirements of rabbits

- Carbohydrates
  - Inhibit motilin
    - Motilin
      - Polypeptide hormone
      - Secreted by cells of
        - » Duodenum
        - » Jejunum
      - Stimulates gastrointestinal tract smooth muscle
  - Starch
    - proliferation of pathogenic bacteria
      - Clostridium spiroforme
        - » Produce toxin

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Nutritional requirements of rabbits

- Carbohydrates
  - Adult rabbits digest starch more efficiently than young
  - Polysaccharides
    - Gluco-oligosaccharides
      - Diarrhea in young rabbits
    - Fructo oligosaccharides
      - Fruits
      - Vegetables
        - » Onion
        - » Chicory
        - » Garlic
        - » Asparagus
        - » Banana
        - » Artichoke
      - Decrease morbidity in rabbits after introduction of pathogenic Escherichia coli
    - Galacto-oligosaccharides

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Nutritional requirements of rabbits

- Volatile fatty acids
  - Cecum fermentation
  - Aid in control of pathogenic organisms
    - Maintain normal pH in cecum
      - pH 6 - 7

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Nutritional requirements of rabbits

- Vitamins
  - Necessary
    - Vitamins A, D, E
  - Vitamins B and K
    - Bacteria in gut synthesize
      - Dietary supplements are unnecessary
  - Increase daily requirements
    - Disease
    - Stress
  - Vitamins A and E
    - Feed preparation and storage destroys
      - Oxidation
    - Alfalfa meal
      - Sufficient vitamin A
    - Vitamin E deficiency
      - Infertility
      - Muscular dystrophy
      - Fetal death
      - Neonatal death

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Noninfectious diseases of rabbits

- Dental disease
  - Present as
    - Excess salivation
    - Teeth grinding
    - Anorexia

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Noninfectious diseases of rabbits

- Dental disease
  - Dental malocclusion
    - Incisors, premolars and molars
      - Grow throughout life
    - Overgrowth of incisors
    - Difficulty in eating and drinking
    - Due to
      - Malnutrition
      - Mistakes in husbandry

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Noninfectious diseases of rabbits

- Dental disease
  - Dental malocclusion
    - Cheek teeth
      - Overgrow
      - Cause
        - » Tongue lesions
        - » Buccal lesions
    - Husbandry
      - Inadequate nutrition

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Noninfectious diseases of rabbits

- Gastric stasis, hair chewing, and hairballs
  - Variety of causes
    - Stress
    - Pain
  - Prey species
    - Not overtly show signs of discomfort or pain
  - Led to
    - Dehydration
    - Pain
    - Hepatic lipidosis
  - Decreased food intake
    - Affects homeostasis
    - Water intake is decreased
    - Decrease energy uptake
      - Produce hepatic lipidosis

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Noninfectious diseases of rabbits

- Gastric stasis, hair chewing, and hairballs
  - Groom themselves constantly
    - Hair normally passes through
    - Excreted with fecal pellets
  - High-fiber diet
    - Fiber mesh
      - Prevents from becoming too dense
      - Hair can more easily pass through
  - Hair chewing
    - Low fiber in diet

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Noninfectious diseases of rabbits

- Ketosis
  - Rare disorder
  - Predisposing factors
    - Obesity
    - Lack of exercise
  - Signs
    - Dullness of eyes
    - Sluggishness
    - Respiratory distress
    - Prostration
    - Death

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Noninfectious diseases of rabbits

- Urolithiasis
  - Signs
    - Hematuria
  - Calcium metabolism
    - Rabbits do not require vitamin D_3
    - Renal elimination of calcium is higher
    - Feeding calcium-rich diet
      - Metabolically inactive rabbit
        - » NOT
          - Growing
          - Pregnant
          - Lactating
      - Abnormal hypercalciuria
      - Calcium
        - » Bladder sludge
        - » Form uroliths

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Noninfectious diseases of rabbits

- Urolithiasis
  - pH increases to 8.5–9.5
    - Normal urine has 8.2
  - Signs
    - Nutritional imbalance
    - Genetic predisposition
    - Infection
    - Inadequate water intake
    - Metabolic disorders
  - Alfalfa
    - High in calcium
    - Switching to
      - Grass
      - Timothy hay

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Nutritional requirements of rabbits

- Water
  - Approximately 120 mL/kg/day
  - Dehydrated rabbits
    - 240 mL/kg/day
    - 10 mL/kg/hr
  - Anorexia
    - Most often also dehydrated
  - Drink more from open bowl than a sipper bottle

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