

Relationship Between Animal Diseases and Nutrition

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[DOI:10.5281/ScienceWorld.14856329](https://doi.org/10.5281/ScienceWorld.14856329)

Introduction

Nutrition plays a fundamental role in animal health, influencing growth, immunity, metabolism, and disease resistance. A well-balanced diet helps in preventing various metabolic and infectious diseases, while deficiencies or imbalances can predispose animals to numerous health disorders. Recent research highlights the intricate relationship between diet, gut microbiota, immune function, and metabolic diseases in animals. This article explores the impact of nutrition on animal diseases, including the role of specific nutrients, the influence of gut microbiota, and emerging insights from comparative studies.

Role Of Nutrition in Disease Prevention:

Proper nutrition is essential for maintaining homeostasis in animals. Nutrients such as water carbohydrates, proteins, fats, vitamins, and minerals serve as fundamental building blocks for body functions, playing critical roles in energy production, immune regulation, tissue repair, and overall metabolic stability. Each nutrients class contributes uniquely to physiological functions such as carbohydrates provide a readily available energy source, proteins support growth and muscle maintenance and their development, fats act as energy reserves and are crucial for cell membrane integrity, steroidal hormones synthesis, fat soluble vitamin regulations while vitamins and minerals facilitate enzymatic reactions, hormone regulation and milk production.

A balanced diet ensures the effective functioning of biological systems, whereas deficiencies or excesses in these nutrients can disrupt metabolic pathways, leading to various health disorders. For instance, inadequate protein intake can result in muscle atrophy, impaired wound healing, and



weakened immune responses, while excessive fat consumption may lead to obesity-related complications such as insulin resistance and cardiovascular diseases. Similarly, vitamin and mineral imbalances can contribute to bone deformities, neurological dysfunctions, and weakened disease resistance. An imbalance in macronutrients and micronutrients contributes significantly to metabolic disorders, immune suppression, and increased disease susceptibility in animals (Arai *et. al.*, 2014). Malnutrition-induced metabolic imbalances can exacerbate chronic conditions such as hepatic lipidosis in felines, ketosis in ruminants, and laminitis in equines. Furthermore, deficiencies in essential trace elements like selenium and zinc have been associated with oxidative stress, reproductive failures, and compromised immune responses, underscoring the importance of precise dietary formulations tailored to species-specific nutritional needs.

Impact of Dietary Proteins on Metabolism and Disease:

Dietary protein quantity and quality have significant effects on an animal's metabolism. Proteins serve as fundamental components of enzymes, hormones, and structural tissues, playing a crucial role in growth, tissue repair, and immune function. The influence of protein intake on body composition, energy expenditure, and food intake regulation.

Protein deficiencies can impair cellular repair mechanisms, hinder muscle development, and weaken the immune response, leading to increased susceptibility to infections and poor overall health of animal. Protein malnutrition results in growth retardation, reduced muscle mass, impaired reproduction, and increased mortality in animals (Chalvon-Demersay *et. al.*, 2017). Conversely, excessive protein intake may lead to metabolic stress, particularly in animals with compromised kidney function, resulting in renal overload, increased nitrogen excretion, and dehydration. Additionally, imbalanced amino acid profiles can disrupt metabolic homeostasis, negatively affecting endocrine regulation and insulin sensitivity. Ruminants, for instance, rely on microbial protein synthesis in the rumen to meet their amino acid needs, whereas monogastric animals, such as pigs and poultry, require precisely balanced dietary amino acids for optimal growth and performance. Furthermore, dietary protein sources, such as plant-based versus animal-derived proteins, impact gut micro-biota composition, influencing nutrient absorption and metabolic efficiency in animals.

Gut Microbiota and Nutritional Health:

The gut micro-biota plays a crucial role in digestion, nutrient absorption, and immune function. Diet-induced alterations in the gut micro-biome can impact disease susceptibility. The presence of beneficial bacteria enhances digestion and boosts immunity, whereas dysbiosis (an imbalance in gut microbiota) is associated with inflammatory diseases and metabolic disorders (Mafra *et. al.*, 2024). For example, dietary fiber has been shown to support beneficial gut bacteria, which in turn modulate



immune responses and reduce the risk of inflammatory bowel disease (IBD) in animals. Prebiotic-rich diets, including foods high in inulin and oligosaccharides, promote the growth of beneficial bacteria such as *Lactobacillus* and *Bifidobacterium*, leading to improved gut health and immune regulation. Similarly, omega-3 fatty acids have been linked to reduced inflammation and improved metabolic health by modulating the composition of gut microbiota, reducing pro-inflammatory cytokines, and enhancing fatty acid metabolism. Furthermore, role of gut microbiota in neurological health through the gut-brain axis. Also, microbial metabolites such as short-chain fatty acids (SCFAs) play a critical role in brain function and behavior. Disruptions in gut microbial balance have been associated with neuro-inflammatory conditions and mood disorders in animals. Therefore, maintaining a healthy gut microbiota through proper dietary interventions can have broad systemic benefits beyond digestion.

Nutritional Deficiencies and Metabolic Diseases:

Metabolic diseases in animals often stem from nutritional imbalances. Deficiencies in vitamins and minerals can cause severe health issues, affecting multiple physiological functions. Some examples include:

- **Vitamin A Deficiency:** Leads to night blindness, reproductive failures, impaired immune function, and increased susceptibility to infections.
- **Calcium and Phosphorus Imbalance:** Causes rickets in young animals, osteoporosis in older animals, and metabolic bone disease in reptiles.
- **Zinc Deficiency:** Results in poor skin health, delayed wound healing, reproductive inefficiencies, and compromised immunity.
- **Iron Deficiency:** Can cause anemia, fatigue, decreased productivity in livestock, and weakened thermoregulation in neonates.
- **Selenium Deficiency:** Leads to muscular dystrophy (white muscle disease), reproductive issues in ruminants, and increased oxidative stress.
- **Iodine Deficiency:** Causes goiter, hypothyroidism, developmental delays, and impaired metabolism.
- **Magnesium Deficiency:** Associated with neuromuscular disorders, grass tetany in ruminants, and poor stress tolerance.
- **Vitamin E Deficiency:** Leads to oxidative damage, muscle degeneration, neurological dysfunction, and impaired fertility.
- **Copper Deficiency:** Results in anemia, weakened immune function, coat depigmentation, and reduced growth rates.
- **Vitamin D Deficiency:** Causes weak bones, increased fracture risk, and metabolic disorders related to calcium homeostasis.



Nutritional Stress and Disease in Wildlife:

Wild animals face nutritional challenges due to habitat destruction, seasonal food shortages, and climate change. Poor nutrition in wildlife can lead to increased stress levels, weakened immunity, and higher susceptibility to diseases (Birnie-Gauvin *et. al.*, 2017). For instance, herbivores that lack dietary diversity may develop digestive issues, while carnivores with insufficient prey availability experience muscle wasting and metabolic dysfunction. Additionally, marine animals, such as seals and penguins, are facing health concerns due to declining fish populations. This impacts their nutrient intake, leading to immune deficiencies and reproductive failures.

Nutrition and Chronic Diseases in Domestic Animals:

In domestic animals, diet-related chronic diseases are a growing concern. Overfeeding and high-fat diets contribute to obesity, diabetes, and cardiovascular diseases in pets such as dogs and cats. Likewise high carbohydrate intake can lead to insulin resistance and diabetes in felines. Similarly excess dietary fat is linked to obesity and liver disease in dogs and low-fiber diets may cause constipation and gastrointestinal issues. Additionally, overconsumption of processed pet foods can lead to kidney disease due to high sodium and phosphorus levels. So the importance of species-specific dietary formulations to prevent chronic diseases and maintain optimal health in companion animals.

Role of Functional Foods in Animal Health:

Functional foods, including probiotics, prebiotics, and nutraceuticals, are increasingly being explored for their health benefits in animals. Probiotics promote gut health, prebiotics enhance beneficial bacterial growth, and nutraceuticals such as antioxidants help combat oxidative stress. For example, supplementation with *Trigonella foenumgraecum* (fenugreek) has shown potential benefits in modulating glucose metabolism and improving overall health in various animal studies. Similarly, dietary polyphenols found in plant-based diets have been linked to reduced inflammation and enhanced immune responses. Additionally, omega-6 and omega-3 fatty acid ratios are being explored for their impact on reducing inflammation and supporting cardiovascular health in animals. Emerging research suggests that dietary interventions focusing on natural antioxidants, such as curcumin and flavonoids, may enhance immune function and reduce oxidative stress in livestock and pets.

Future Perspectives:

Advancements in nutrigenomics and precision nutrition are paving the way for more targeted dietary interventions in animal health. By understanding genetic predispositions and metabolic responses to specific nutrients, to develop customized dietary plans to prevent diseases and improve longevity in animals. Sustainable animal nutrition is gaining importance in reducing environmental stress for livestock and also alternative protein sources such as insect-based feed, fermented plant



proteins, and algae-derived omega fatty acids are being used to create balanced diets that support both animal health and production.

Conclusion:

The relationship between nutrition and diseases in animals is complex phenomena. Ensuring balanced nutrition, promoting gut health microbiota, and incorporating functional foods can significantly enhance disease resistance and overall well-being in animals.

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