Flatulence: Causes and Management Options

Hill’s Science and Technology Center
Topeka, Kansas
Philip Roudebush, DVM, DACVIM

ABSTRACT: Flatulence is defined as excessive formation of gases in the stomach or intestine. It is usually associated with noticeable flatus, belching, borborygmus, abdominal distention, or a combination of these signs. Excessive aerophagia is a risk factor for flatulence and is noted commonly in brachycephalic, working, and sporting breeds as well as in dogs with aggressive or competitive eating behaviors. The primary goal of dietary management of flatulence is to reduce the gas formation that results from bacterial fermentation of intestinal substrates.

Flatulence—excessive formation of gases in the stomach or intestine—is usually associated with noticeable flatus, belching, borborygmus, abdominal distention, or a combination of these signs. Flatus, rather than flatulence, is the term that should be used for gas expelled through the anus. Belching is the noisy voiding of gas from the stomach through the mouth, and borborygmus is a rumbling or gurgling noise caused by propulsion of gas through the intestines.

Excessive flatus is a chronic, objectionable problem that is common in dogs but less so in cats. Although belching, borborygmus, and abdominal distention are less common signs, pet owners may mention them if asked specifically about them. Flatus, belching, and borborygmus occur in healthy pets but may also develop as a consequence of gastric, small intestinal, or colonic disorders.

PRODUCTION OF INTESTINAL GAS

The tendency to treat flatus as a humorous topic has obscured appreciation of the complex physiology that underlies the formation of intestinal gas. The quantitatively important gases in the intestinal tract are nitrogen (N₂), oxygen (O₂), hydrogen (H₂), carbon dioxide (CO₂), and methane (CH₄).¹-⁴ These odorless gases make up more than 99% of the intestinal gas volume in humans and pets (Table 1). The characteristic unpleasant odor of intestinal gas arises primarily from the trace gases that contain volatile sulfur compounds such as hydrogen sulfide, methanethiol, and dimethylsulfide.⁵ The noxious odor of flatus in both humans and dogs correlates most strongly with the concentration of hydrogen sulfide.⁵,⁶

Gas occurs naturally in the gastrointestinal (GI) tract and primarily results from the following four events¹⁴⁻⁷:
The interaction between hydrochloric acid and alkaline food, saliva, or bicarbonate secreted by the pancreas produces CO₂ in the stomach and intestines. CO₂ also enters the GI tract through diffusion from the blood. Belched gas is largely swallowed air plus variable quantities of CO₂.

A large amount of gas is formed from bacterial fermentation in the colon. Substrates for bacterial gas production include dietary substances (e.g., fiber, poorly digestible protein, carbohydrates) and endogenous sources (e.g., mucin, bile acids). Foods that contain large amounts of nonabsorbable oligosaccharides (e.g., raffinose, stachyose, verbascose) are likely to produce large amounts of intestinal gas.

Dogs and cats lack the digestive enzymes needed to split these sugars into absorbable monosaccharides. Therefore, bacteria in the colon rapidly ferment these sugars, producing H₂ and CO₂. Soybeans, beans, peas, and other legumes contain large quantities of nonabsorbable oligosaccharides and are often associated with excessive flatus. Many fibers used in pet foods are fermented by colonic microflora and may contribute directly to flatus. Rapidly fermentable fibers in pet foods include pectins and most gums. Fiber-containing foods may contribute to flatus indirectly through reduced dry-matter digestibility. Intestinal gas production is also increased by fresh or dried foods containing fructose, resistant starches, and fermentable fiber (e.g., apples, grapes, prunes, raisins, bananas).

Diseases that cause maldigestion or malabsorption are often associated with borborygmus, abdominal distention, and excessive flatus because large amounts of nonassimilated substrates are available for bacterial fermentation. Flatus is also common in adult dogs and cats fed excessive amounts of lactose-containing foods.

Sulfur-containing gases are the major malodorous components of human and canine flatulence. Dietary sources of sulfur (sulfates and sulfur-containing amino acids) and endogenous sulfur-containing compounds (e.g., mucin, taurocholate) are converted by sulfate-reducing bacteria to the odoriferous compounds hydrogen sulfide, methanethiol, and dimethylsulfide. Onions, nuts, spices, cruciferous vegetables (e.g., broccoli, cabbage, cauliflower, Brussels sprouts) and carrageenan contain high levels of sulfate and often increase production of malodorous gases; high-protein ingredients may also contribute to production of such gases.

**PATIENT ASSESSMENT**

Pet owners often express concerns with clinical manifestations of flatulence and may describe an

<table>
<thead>
<tr>
<th>Table 1. Types and Sources of Intestinal Gas</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type of Gas</strong></td>
</tr>
<tr>
<td>-----------------</td>
</tr>
<tr>
<td><strong>Quantitatively Important Intestinal Gases</strong></td>
</tr>
<tr>
<td>Nitrogen</td>
</tr>
<tr>
<td>Oxygen</td>
</tr>
<tr>
<td>Hydrogen</td>
</tr>
<tr>
<td>Carbon dioxide</td>
</tr>
<tr>
<td>Methane</td>
</tr>
<tr>
<td><strong>Odoriferous Gases</strong></td>
</tr>
<tr>
<td>Volatile sulfur compounds</td>
</tr>
<tr>
<td>(hydrogen sulfide, methanethiol, dimethylsulfide)</td>
</tr>
</tbody>
</table>
increase in frequency of belching, flatus or 
borborygmus, objectionable odor of flatus, or 
abdominal distention. In one study, 14 of 110 dog 
owners (43%) reported flatus in their otherwise-healthy 
dogs and 14 owners (13%) reported objectionable odor 
associated with the flatus episodes. Dogs housed 
indoors and less active dogs were more likely to have 
evidence of flatus. Temperament, frequency of 
feeding, specific diet, eating habits, age, gender, and 
history of previous GI disease were not found to be risk 
factors for flatulence in this particular study.

A history of dietary change or dietary indiscretion 
may be associated with the flatulence. Specific foods, 
primary food ingredients, treats, supplements, and 
opportunities for dietary indiscretion should be 
evaluated. A thorough assessment should also include 
verification of the current feeding method. Factors to 
consider include feeding frequency, amount fed, how 
food is offered, access to other food, relationship of 
feeding to exercise, and who feeds the animal.

There is widespread belief that some individuals are 
consistently more flatulent than others. Studies in 
humans have shown great variability in the frequency 
of flatus, and such variation probably occurs in animals 
as well. Rectal gas excretion rates in humans range 
from 400 to 1500 ml/day (mean 705 ml/day). 
Humans, eating their usual diet, passed gas per rectum 
an average of 8 to 10 times per day with an upper 
normal limit of 20 times per day. In general, 
frequency of flatus correlates with the volume of 
intestinal gas; thus increases and decreases in episodes 
of flatus can be used to obtain a relative idea of changes 
in intestinal gas volume. Studies of rectal gas excretion 
rates in pets whose owners complain of flatus have not 
been conducted.

Occasionally, belching, abdominal distention, and 
flatus develop in conjunction with other GI signs, 
including weight loss, diarrhea, and steatorrhea. This 
history is very suggestive of an underlying small 
stomach disorder. Examples of chronic intestinal 
disorders often associated with flatulence include 
exocrine pancreatic insufficiency, inflammatory bowel 
disease, small intestinal bacterial overgrowth, wheat- 
sensitive enteropathy, food sensitivity, and lymphangiectasia. In one study, 18 of 70 cats (26%) with chronic 
diarrhea and/or vomiting had flatus and 8 cats (11%) 
had abdominal distention.

Cats with clinical evidence of flatulence should always be closely evaluated for underlying chronic GI problems such as inflammatory bowel disease or food sensitivity.

Excessive aerophagia is a risk factor for flatulence and is seen with brachycephalic, working, and sporting dogs as well as those with aggressive and competitive eating behaviors. Dietary indiscretion and ingestion of certain pet food ingredients may be risk factors for some individual animals. Excessive belching, rapid eating, and aerophagia have also been identified as risk factors for gastric dilatation-volvulus and should be considered important clinical findings in dogs at risk for this disorder.

In most cases, physical examination findings in dogs 
and cats with flatulence are unremarkable. Intestinal 
gas can often be detected during abdominal palpation, 
but assessing the quantity of gas from palpation alone is 
difficult. Laboratory testing is usually not indicated. 
Animals may be in poor body condition if 
objectionable flatus is secondary to an underlying GI 
condition. Further evaluation is in order if vomiting, 
diarrhea, or weight loss are also present.

**FEEDING PLANS FOR PATIENTS 
WITH FLATULENCE**

Dietary management of flatulence is primarily 
concerned with decreasing the intestinal gas that results 
from bacterial fermentation of undigested food (Table 
2). Animals with excessive or objectionable flatus 
generally benefit from highly digestible foods (dry- 
matter digestibility >90%) offered in small, frequent 
meals. This protocol reduces the food residues available 
for bacterial fermentation in the large intestine and 
should reduce gas production.

Certain protein, carbohydrate, and fiber ingredients 
or levels may affect flatus production in individual 
animals. Of the numerous foods alleged to enhance 
flatus in humans, baked beans are the only natural food 
that has been carefully studied. A diet deriving half of its 
calories from baked beans increased flatus in humans 
from a basal level of 15 to 176 ml/hour. Flatulent 
animals may benefit from eating foods that do not 
contain sources of legumes (e.g., soybean meal, soybean 
mill run, soy hulls, peas, pea fiber, pinto beans).

Changing the source of dietary protein or carbohy- 
drates may benefit some flatulent animals. In general, 
aerophagia and dietary carbohydrate are the primary 
contributors to the volume of intestinal gas, whereas 
dietary protein contributes to the odoriferous gases. 
Reports have confirmed that a diet in which all 
carbohydrates are supplied by white rice reduces 
testinal gas formation in humans.20,21 Studies in 
dogs also suggest that less intestinal gas is produced 
when the primary source of carbohydrates is rice than 
when it is other sources of carbohydrate such as wheat 
or corn (Figure 1).23 Therefore, suggesting the use of 
commercial or homemade foods containing rice as the 
primary or only source of carbohydrate for flatulent 
dogs and cats is a prudent recommendation (Table 3).
For example, changing from a commercial dry food that contains corn, chicken meal, and soybean meal to a dry food that contains lamb meal, rice, and barley may be helpful.

Vegetable-based foods containing strongly flavored, sulfur-containing vegetables or legumes should be avoided in flatulent patients. In some cases, reducing dietary protein content alleviates odoriferous flatus. In most cases, vitamin–mineral supplements should be avoided because these products can alter intestinal microbial activity. Because lactose in food and treats (e.g., cheese, ice cream, milk) may contribute to flatulence in adult animals, foods containing lactose should be eliminated from the diet. Foods that are high in fructose, resistant starch, and/or fermentable fiber should also be avoided. A series of dietary trials is often successful in finding a food that reduces excessive flatulence or objectionable flatus in individual pets.

Reducing aerophagia is important to control flatulence in dogs, especially brachycephalic breeds. Several small meals should be given daily to discourage rapid eating and gulping of air. Feeding in a quiet, isolated location eliminates competitive eating and reduces aerophagia. These same feeding methods plus feeding a mixture of moist and dry foods may be helpful in reducing the risk of gastric dilatation–volvulus in dogs.

Surgical correction of stenotic nares and overlong soft palates may help reduce aerophagia in some brachycephalic dogs. Simple changes to feeding routines may also reduce objectionable flatus. If possible, dogs should be walked outdoors within 30 minutes of meals. This encourages defecation and elimination of intestinal gas. Less active dogs are at higher risk for objectionable flatus.

### Table 2. Management of Patients with Flatulence

<table>
<thead>
<tr>
<th>Control Aerophagia</th>
<th>Decrease Intestinal Gas Production</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Feed several small meals daily</td>
<td>• Feed a highly digestible food (dry-matter digestibility &gt;90%)</td>
</tr>
<tr>
<td>• Discourage rapid or competitive eating</td>
<td>• Change to foods with rice as the sole or predominant carbohydrate source</td>
</tr>
<tr>
<td>• Feed a mixture of moist and dry foods</td>
<td>• Avoid foods containing ingredients from legumes such as soybean meal, soybean mill run, peas, and pea fiber</td>
</tr>
<tr>
<td>• Surgically correct stenotic nares and elongated soft palate in brachycephalic dogs</td>
<td>• Eliminate vitamin, mineral, or fat supplements</td>
</tr>
</tbody>
</table>

### Decrease Substrates That Cause Noxious Gas Production

<table>
<thead>
<tr>
<th>Decrease Substrates That Cause Noxious Gas Production</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Change the dietary protein sources</td>
</tr>
<tr>
<td>• Decrease dietary protein levels</td>
</tr>
<tr>
<td>• Eliminate vitamin, mineral, or fat supplements</td>
</tr>
<tr>
<td>• Avoid onions, nuts, spices, or cruciferous vegetables (broccoli, cabbage, cauliflower, brussels sprouts)</td>
</tr>
<tr>
<td>• Avoid canned pet foods that contain carrageenan</td>
</tr>
</tbody>
</table>

### Increase Activity and Exercise (which generally results in fewer problems with flatus)

<table>
<thead>
<tr>
<th>Increase Activity and Exercise (which generally results in fewer problems with flatus)</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Walk dogs outdoors within 30 minutes of meals to encourage defecation and elimination of intestinal gas</td>
</tr>
</tbody>
</table>

---

**Figure 1**—Mean breath hydrogen concentrations in dogs after fasting; ingestion of a therapeutic food containing lamb and rice; and ingestion of flour derived from rice, wheat, or corn. Hydrogen can be produced in the body only through bacterial fermentation of carbohydrate sources. As a result, breath hydrogen concentrations correlate with overall production of intestinal gas. Gas production is minimal with fasting, ingestion of rice flour, and ingestion of foods containing lamb and rice as the major ingredients. (Adapted from Washabau RJ, Strombeck DR, Buffington CA, Harrold D: Evaluation of intestinal carbohydrate malabsorption in the dog by pulmonary hydrogen gas excretion. *Am J Vet Res* 47:1403–1404, 1986.)
### MEDICAL THERAPY

Carminatives are medicines or preparations that relieve flatulence. Various herbal and botanical preparations have been used for thousands of years as carminatives. More recently, commercial products have been introduced that claim to reduce or control flatulence. Such products include activated charcoal, bismuth subsalicylate, zinc acetate, simethicone, *Yucca schidigera* preparations, α-galactosidase, and pancreatic enzyme supplements; these products can be used in conjunction with an altered feeding plan. Nonabsorbable antibiotics, such as neomycin, have also been shown to reduce flatulence and the number of flatus episodes in healthy humans and dogs. However, routine use of nonabsorbable antibiotics in otherwise-healthy pet animals with flatulence is not indicated.

Dry activated charcoal adsorbs virtually all odoriferous gases when mixed directly with human feces and flatus gas. However, ingestion of activated charcoal in humans has not been effective in reducing the number of flatus events, volume of released intestinal gas, fecal odor, or breath H$_2$ excretion after bean ingestion. In vitro studies suggest that ingested charcoal fails to reduce liberation of volatile sulfur compounds because of saturation of charcoal binding sites during passage through the gut. Wetting activated charcoal can slow uptake of sulfur-containing gases considerably. Activated charcoal is found in several commercial canine treats purported to control flatulence.

Bismuth subsalicylate (BSS) reduces the odor of feces and flatulence in humans when taken frequently (four times daily). Bismuth is the active ingredient and avidly adsorbs hydrogen sulfide, forming insoluble bismuth sulfide. Bismuth sulfide imparts a characteristic black color to feces. Bismuth also has antibacterial activity, which may account for some of the effects. BSS contains 50% bismuth by weight and is found in various commercial veterinary antidiarrheal–adsorbent products as well as in over-the-counter antidiarrheal products for human use (e.g., Pepto-Bismol®, Procter and Gamble, Cincinnati, OH). There appears to be a striking dose-dependent response with BSS: 400 mg/100 g of dry food completely suppresses cecal hydrogen sulfide release in rats, whereas one fifth of this concentration has no demonstrable effect. This agent may be effective in controlling objectionable flatus in pets but probably needs to be given several times per day, which precludes practical, long-term use. It should be used with caution in cats because of concerns with salicylate toxicity.

Similar to bismuth, zinc acetate binds sulphydryl compounds and has also been shown to reduce volatile sulfur compounds when exposed directly to gas from

### Table 3. Commercial Pet Foods with Rice as the Sole or Predominant Carbohydrate Source

<table>
<thead>
<tr>
<th>Dry Dog Foods</th>
<th>Moist Dog Foods</th>
<th>Dry Cat Foods</th>
<th>Moist Cat Foods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hill’s® Science Diet® Lamb Meal &amp; Rice Formula</td>
<td>Hill’s® Prescription Diet® Canine d/d® Lamb &amp; Rice</td>
<td>Hill’s® Science Diet® Feline Adult Savory Recipes</td>
<td>Hill’s® Prescription Diet® Feline d/d®</td>
</tr>
<tr>
<td>Canine Growth®</td>
<td>Hill’s® Prescription Diet® Canine d/d® Whitefish &amp; Rice</td>
<td>Hill’s® Science Diet® Sensitive Stomach Adult Cat</td>
<td>IVD Select Care™ Feline Control Formula®</td>
</tr>
<tr>
<td>Hill’s® Science Diet® Lamb Meal &amp; Rice Formula</td>
<td>Iams® Beef &amp; Rice Formula™</td>
<td>Hill’s® Science Diet® Sensitive Skin Adult Cat</td>
<td>Eukanuba® Veterinary Diets® Low–Residue™ Adult/Feline</td>
</tr>
<tr>
<td>Canine Adult</td>
<td>Hill’s® Prescription Diet® Feline g/d®</td>
<td>Hill’s® Prescription Diet® Feline k/d®</td>
<td>Eukanuba® Veterinary Diets® Low pH/S™/Feline</td>
</tr>
<tr>
<td>Hill’s® Science Diet® Sensitive Stomach Adult Dog</td>
<td>Eukanuba® Feline Formula Cat Food</td>
<td>Iams® Chicken Formula Cat Food</td>
<td>Eukanuba® Veterinary Diets® pH/O™/Feline</td>
</tr>
<tr>
<td>Hill’s® Prescription Diet® Canine d/d® Rice &amp; Egg</td>
<td>Iams® Chicken &amp; Rice Active Maturity™</td>
<td>Iams® Chicken &amp; Rice Senior Formula</td>
<td>Iams® Chicken &amp; Rice Formula</td>
</tr>
<tr>
<td>Hill’s® Prescription Diet® Canine d/d® Rice &amp; Salmon</td>
<td>Iams® Chicken &amp; Rice Senior Formula</td>
<td>Iams® Chicken &amp; Rice Formula</td>
<td>Iams® Chicken &amp; Rice Formula</td>
</tr>
<tr>
<td>Hill’s® Prescription Diet® Canine g/d®</td>
<td>Iams® Active Maturity™ Chicken &amp; Rice Formula</td>
<td>Nutro® Natural Choice™ Lamb Meal &amp; Rice Formula™</td>
<td>Eukanuba® Lamb &amp; Rice Formula Cat Food</td>
</tr>
<tr>
<td>Hill’s® Prescription Diet® Canine k/d®</td>
<td>Nutro® Natural Choice™ Dental Care Lamb Meal &amp; Rice Formula</td>
<td>Nutro® Natural Choice™ Lamb Meal &amp; Rice Formula™</td>
<td>Nutro® Natural Choice™ Cat</td>
</tr>
<tr>
<td>Purina Veterinary Diets™ LA Limited Antigen™ Canine Formula®</td>
<td></td>
<td>Nutro® Natural Choice™® Lamb Meal &amp; Rice Formula™</td>
<td></td>
</tr>
</tbody>
</table>

---

*This list contains specialty and therapeutic brand pet foods readily available in North America. Other pet foods may also be appropriate. For more information, consult the ingredient list on the pet food label or contact the manufacturer.

©Hill’s Pet Nutrition, Inc., Topeka, KS.

©Hill’s Pet Purina, St. Louis, MO.

©Nutro Products, Inc.; City of Industry, CA.

©Iams and Eukanuba products are manufactured by The Iams Company, Dayton, OH.

©Innovative Veterinary Diets (IVD), Pittsburgh, PA.
human flatus.7 Adding zinc acetate to food (1% total diet) decreased fecal hydrogen sulfide concentrations and improved flatus odor in rats.29 One report showed that an oral treat containing zinc acetate, activated charcoal, and Y. schidigera extract reduced highly odoriferous episodes of flatus in dogs.

Simethicone (dimethylpolysiloxane) is an antifoaming agent that reduces surface tension of gas bubbles and is found in commercial veterinary products and over-the-counter products for human use.30 The mechanism of effect of simethicone in flatulent patients has not been determined—perhaps the altered gas bubbles are more effectively eliminated. A few controlled trials of simethicone treatment have been conducted in humans.31–33 In general, simethicone had no effect on total daily flatus volume, number of flatus episodes, or average volume per flatus event.31–33 Simethicone may help reduce gastric accumulation of gas and alleviate upper GI signs. The effectiveness of simethicone in controlling flatulence in pets is unknown, and it would not be expected to control objectionable flatus odors.

Extracts of the Y. schidigera plant have been used to control malodorous feces in animal-waste lagoon systems.34–36 The mechanisms of action are poorly understood and may include “binding” of ammonia or alterations in microbial activity. In the United States, yucca preparations are approved only as flavoring agents in pet foods and it is unknown whether they effectively control flatulence or objectionable flatus odors when ingested by pet animals. An oral treat containing Y. schidigera extract, activated charcoal, and zinc acetate reduced highly odoriferous episodes of flatus in dogs.27 Products containing α-galactosidase are available as human (Beano®, AkPharma, Pleasantville, NJ) and veterinary (CurTail™, AkPharma) products. These products reduce flatus volume by improving digestion of the nonabsorbable oligosaccharides found in soybeans, beans, peas, and other legumes.37 These products would not be expected to improve excessive flatus resulting from other causes (e.g., aerophagia) or to reduce the odor of flatus. Anecdotal reports suggest that these products may be beneficial in some animals.

Pancreatic enzyme supplementation has been shown to decrease abnormal intestinal gas production in dogs with exocrine pancreatic insufficiency.22 Pancreatic enzyme preparations have also been widely used for bloating and abdominal distention in humans. Because ingestion of these preparations should add little to the enzyme output of the pancreas in otherwise-normal individuals, no solid rationale exists for their use in flatulent patients without pancreatic disease. Nevertheless, a recent study showed that a microencapsulated pancreatic enzyme preparation significantly reduced postprandial symptoms of bloating and abdominal distention in healthy humans ingesting a high-calorie, high-fat meal.38 This finding suggests that pancreatic enzyme supplements might benefit some patients with flatulence.

More than 30 herbal and botanical preparations have been listed as carminatives.59 Grape seed extract containing proanthocyanidins is one botanical preparation that has been shown to alter GI microflora and decrease fecal release of volatile sulfur compounds in human patients.40 The dosage, safety, and efficacy of this and other botanical preparations in pets with flatulence have not been established.

To date, the best evidence exists for short-term use of BSS, zinc acetate, and nonabsorbable antibiotics as carminatives. Less evidence exists for use of activated charcoal, simethicone, digestive enzyme preparations, yucca extract, and grape seed extract. Changing the feeding plan (food and feeding method), rather than using carminatives, offers the best opportunity for successful long-term management of flatulence in pets.

**MONITORING PATIENTS WITH FLATULENCE**

Patients should be evaluated for evidence of malassimilation if the feeding methods and ancillary therapy outlined here are not successful in reducing or controlling flatulence. Relapse in animals that have been previously asymptomatic often indicates dietary indiscretion. The prognosis for control of flatulence is good in most cases. However, pet owners should be educated about normal intestinal gas production and not expect complete cessation of flatulence, especially in pets with excessive aerophagia.41 In some cases, the following advice may still be necessary: “After trying empirical therapy for pets with chronic flatulence, sound advice for the client is to always stand upwind from the patient.”42

**REFERENCES**

6. Giffard CJ, Collings SB, Stoodley RM: Ability of an anti-


2. The characteristic unpleasant odor of intestinal gas correlates most strongly with concentration of which of the following?
   a. methane  
   b. methanethiol  
   c. nitrogen  
   d. hydrogen sulfide  
   e. carbon dioxide

3. Which of the following is believed to contribute most to the volume of gas in the digestive tract?
   a. aerophagia  
   b. interaction of hydrochloric acid with alkaline food, saliva, and pancreatic bicarbonate  
   c. diffusion of gases from the blood  
   d. bacterial metabolism and fermentation in the large intestine  
   e. bacterial metabolism and fermentation in the small intestine

4. Hydrogen and methane found in intestinal gas are only produced by which of the following?
   a. aerophagia  
   b. interaction of hydrochloric acid with alkaline food, saliva, and pancreatic bicarbonate  
   c. diffusion of these gases from the blood  
   d. bacterial metabolism and fermentation

5. Which of the following is a nonabsorbable oligosaccharide commonly found in legumes?
   a. galactose  
   b. fructose  
   c. sucrose  
   d. raffinose  
   e. xylose

6. Which of the following was found to be a risk factor for flatus in dogs?
   a. frequency of feeding  
   b. age  
   c. gender  
   d. history of previous GI disease  
   e. less activity

7. Rapid eating, aerophagia, and belching have been identified as risk factors for which of the following conditions?
   a. pancreatitis  
   b. gastric dilatation–volvulus  
   c. inflammatory bowel disease  
   d. small intestinal bacterial overgrowth  
   e. lactose intolerance

8. Intestinal gas production is lowest for which of the following ingredients?
   a. rice  
   b. corn  
   c. wheat  
   d. soybean meal  
   e. barley

9. Products containing α-galactosidase would be expected to control flatulence associated with which of the following ingredients?

10. Changing the dietary protein source or decreasing dietary protein levels will do which of the following?
   a. help control aerophagia  
   b. decrease the amount of intestinal gas  
   c. decrease production of malodorous gases  
   d. encourage defecation and elimination of intestinal gas  
   e. discourage rapid or competitive eating situations