



PetBiome

Report

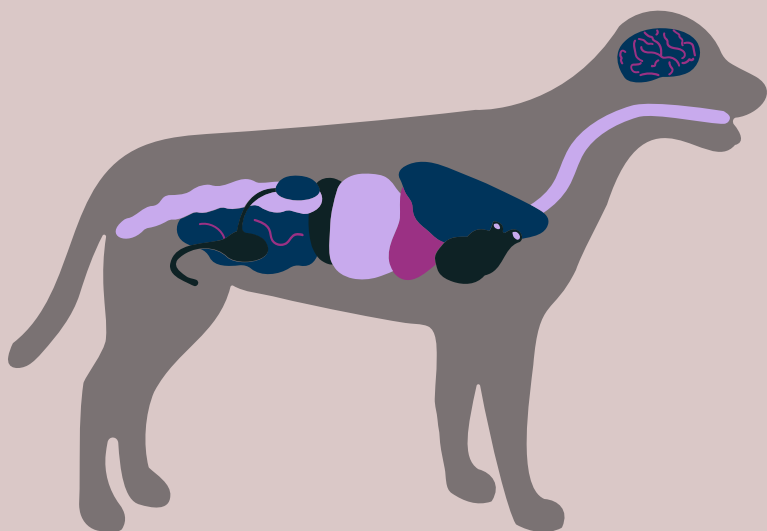


Prepared For

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Part 1. Anatomy of the Biome



The entire gastrointestinal tract is home to trillions of bacteria that affect health and vitality

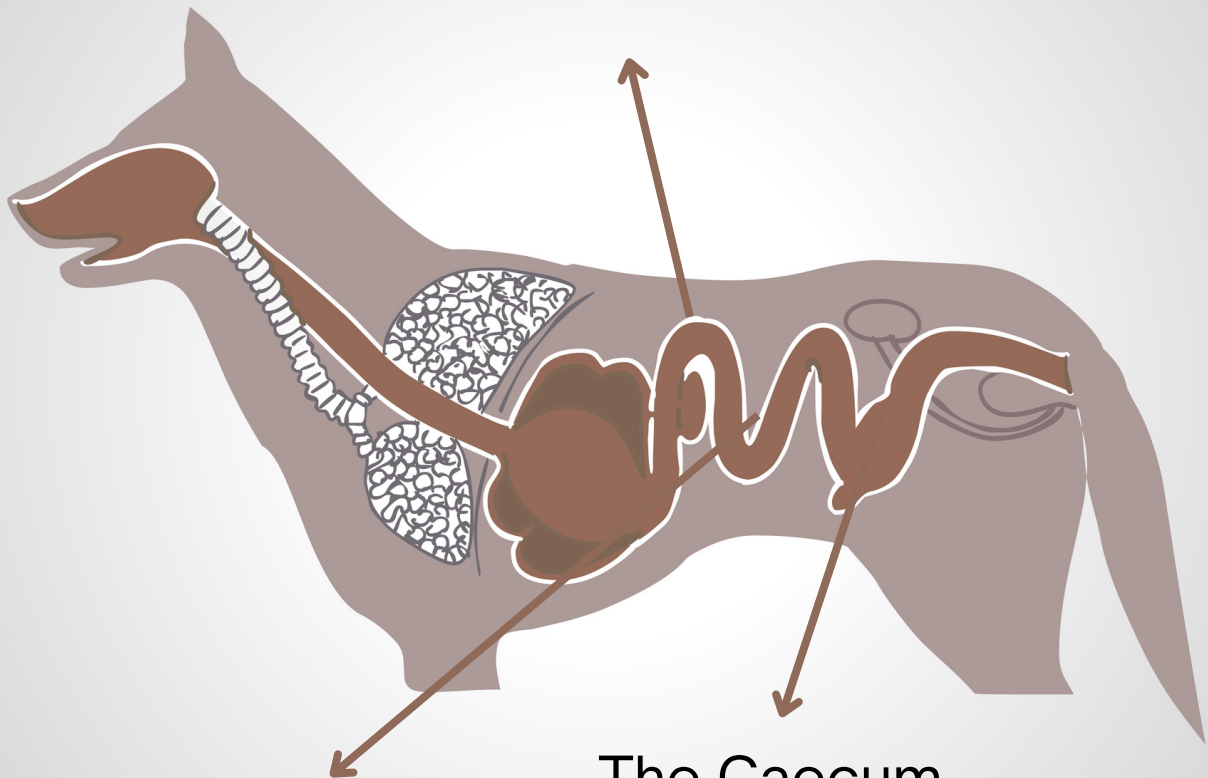
Small Intestine

Protein, fat, carbohydrate, trace elements, vitamins, and water are mainly absorbed in this part of the G.I. tract.

Excessive bacteria in the small intestine causes a disorder called SIBO with symptoms that include (diarrhea, gas and vomiting).

Sections of your report relating to the small intestine include

vitamin and protein metabolism



The Large Intestine

Is an area of high microbial diversity, the right ventral colon is the most diverse of the whole gastrointestinal tract. Residents within this part of the gut are prolific producers of butyrate, known to have a protective role in the gut. Also the area where pathogen digesting bacteria live.

Sections of your report relating to the large intestine include-
Bloating and hydrogen production

The Caecum

The caecum is a holding vat where a high proportion of bacteria reside. The bacteria are responsible for fermenting the indigestible parts of the diet (bones) and converting them to energy, producing secondary chemicals with health benefits and vitamins and other nutrients. Water is absorbed here.

Sections of your report relating to the microbes in the caecum include-

Fibre digestion, bloating Immune function, metabolism and inflammation

About the Microbiome

The Microbiome

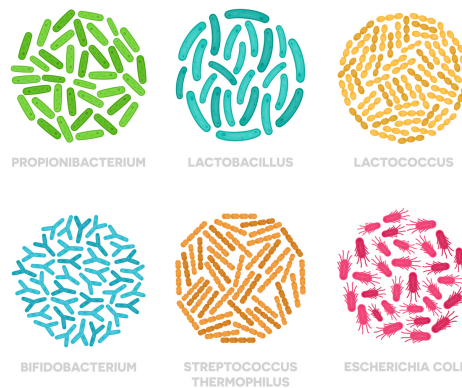
The microbiota comprises a community of bacteria that live in the gut of all mammals that are species specific, this report relates to the dog.

The Good Gut Bacteria-

Make vitamins and allow minerals to be absorbed

Mend the gut wall and prevent ulcers and inflammation

Defend against the invasion of bad bacteria Increase energy and promote a good immune response.



The Bad Gut Bacteria

Cause disease -colitis, IBD, SIBO, gastritis, inflammation food sensitivities and allergies. Create imbalances, triggered by changes in diet, stress, commonly used medication, including the use of antibiotics and pain medication.

Re-balancing the Gut

Is much easier if you know what and where these imbalances are. Scientific research has linked every common gastrointestinal health problem to the gut bacteria.

The Petbiome Report identifies 3 states.

1. A Balanced Microbiome
2. A biome in the state of dysbiosis or imbalance, too many bad bacteria, good bacteria present but in too few numbers.
3. Complete absence of good gut bacteria.

Contact Us

email- through the website www.petbiome.org

More about the Microbiome

The Report

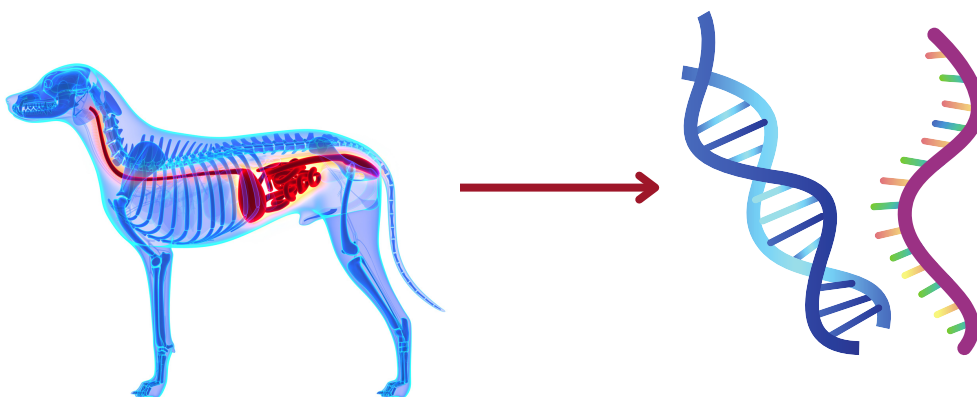
This report is an analysis of the 16S rRNA gene which is present in all bacteria and is the most accurate method of identifying bacterial species. It provides a real time snapshot of the hindgut microbial community of your dog.

Whilst the test is a powerful management and analytical tool, it is not intended to be used to diagnose any illness, please consult your vet if your dog is in discomfort. To generate this report The Illumina MiSeq is used, which is the most accurate and up to date technology, chosen by genomic researchers around the world.

In dogs, the knowledge and science linking microbiome to health and disease, are in their infancy. In humans this area of science is much more advanced because of the larger database of samples. It is our aim to gather as many samples of different groups (populations) of dogs as we can, this will help to increase our knowledge and put it in line with human research, offering the best and most accurate service.

The PetBiome Data Library

We have the largest library of canine microbiome data in the world, used to identify and accurately describe the healthy biome. The data base consists of faecal samples from dogs of all ages and breeds. We then profile the microbiome using artificial intelligence and population data. Since 2007 we have collected thousands of samples from dogs with obesity, allergies, arthritis, gastric discomfort, inflammatory bowel disease, diarrhoea and more. We have also profiled the microbial communities of dogs on different diets and work with many vet practices profiling disease and dysbiosis. The use of long term medication can have a profound effect on the microbiome most commonly antibiotics, anthelmintics, steroids and non steroidal anti-inflammatories, use of these medications has the effect of reducing diversity, we have worked for many years on how to restore the extensive and diverse microbial community through dietary management and the use of plant compounds and secondary metabolites.



The Petbiome analysis sequences the rRNA of the gut bacteria to give information in real time

Part 2. Your Dog



The Three Biome States

The microbiome can be defined in 3 different basic states

1. Stable, with a well constructed and defined core community.
2. Imbalanced (core beneficial bacteria present but at the wrong levels)
3. Missing members of the good gut bacteria (a portion of the core beneficial bacteria are not present). Can also be Imbalanced and missing a part of the biome.

This information has been calculated from the identification of thousands of species of bacteria from within your dogs gut, which is then compared to the phylotypes of healthy/ unhealthy dogs within our data base.

Your Pet

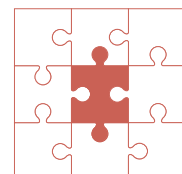
An Imbalanced and Missing Part of the Biome

Imbalanced

The core members of the microbiome are present but percentages of each are at the wrong levels described as dysbiosis. There is an increased opportunity for inflammation and infection to develop and the imbalance may be reflective of disease in the gut or elsewhere in the body such as allergies, food sensitivities, IIBS etc. Dogs with this type of microbiome are sensitive to changes in management and diet.

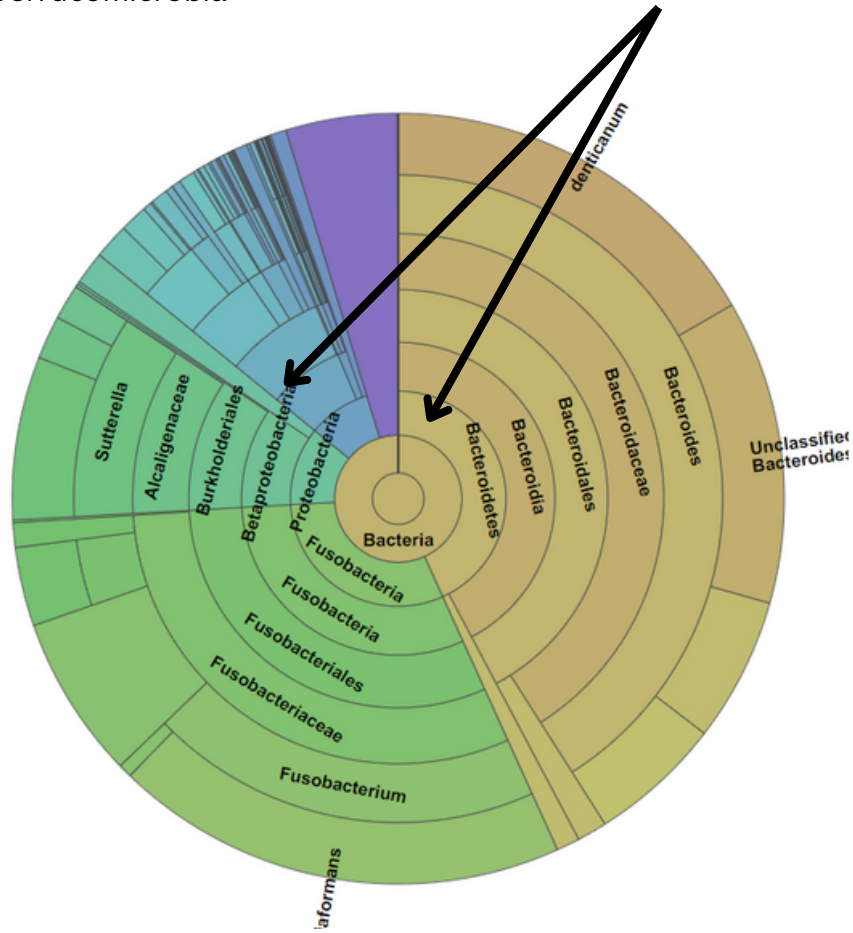
Missing

There are specialized bacteria responsible for protecting the host against invading pathogens, environmental pollutants, and environmental bacteria. There are others that are linked to energy production and the endocrine system. These bacteria are either extremely low or missing altogether. Causes can be the use of long- term medication such as NSAID's, omeprazole or antibiotics, processed food, eutrophication (high mineral supplements) and some anthelmintics. It is possible to repopulate the gut with good gut bacteria though for some dogs recovery can take some time.



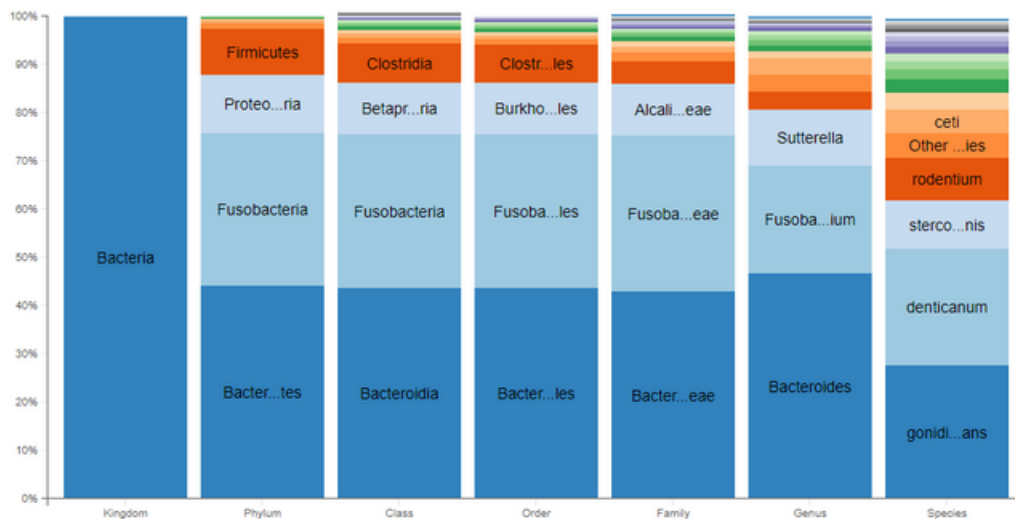
Biome Analysis

Missing verrucomicrobia Imbalanced bacteroidetes/firmicute ratio



TOP 20 CLASSIFICATION RESULTS BY TAXONOMIC LEVEL

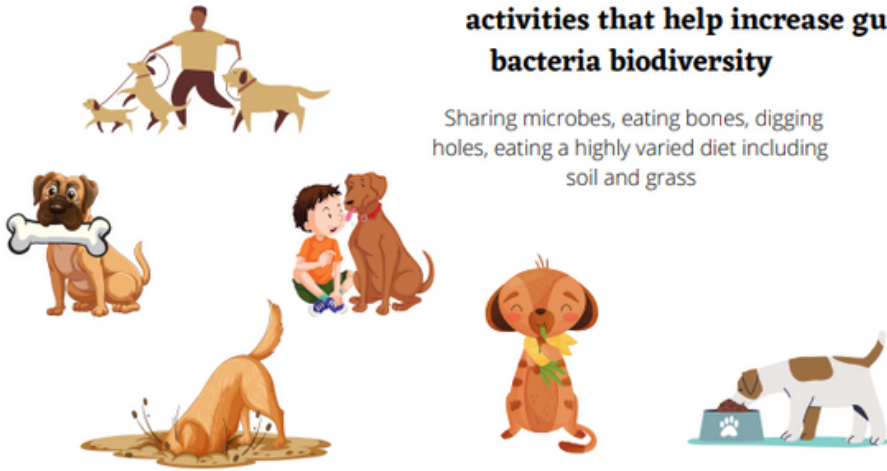
This column chart shows the relative abundance of the top 20 classification results within each taxonomic level. Mouse over any category to see its description and abundance.



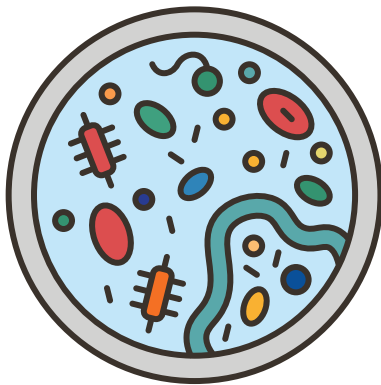
Diversity Score

activities that help increase gut bacteria biodiversity

Sharing microbes, eating bones, digging holes, eating a highly varied diet including soil and grass



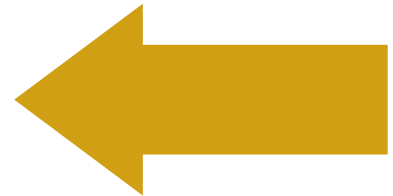
Your Dog's Diversity Score (Shannon Index)



Low < 2.1

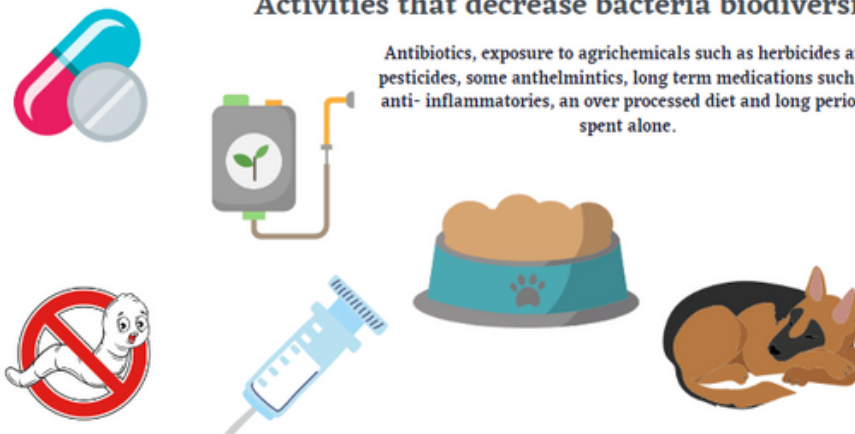
Medium 2.1-2.5

High > 2.5



Activities that decrease bacteria biodiversity

Antibiotics, exposure to agrichemicals such as herbicides and pesticides, some anthelmintics, long term medications such as anti-inflammatories, an over processed diet and long periods spent alone.



Environmental Pollutants and the Microbiome

Glyphosate-based herbicides (GBHs) are the most frequently used herbicides globally. Residues from the use of GBH's have a profound effect on the microbiome of animals and humans, reducing the ability of the microbiome to protect the host against free radical damage and increasing oxidative stress.

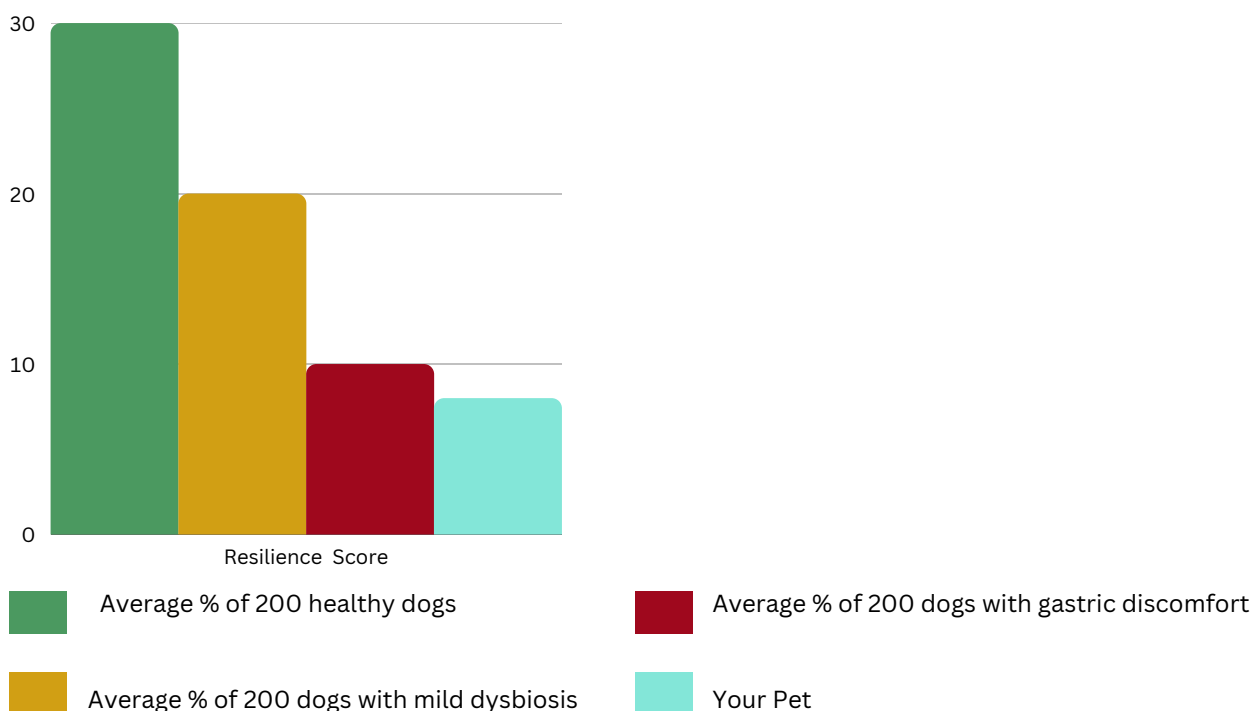
The microbiome exposed to GBH residue becomes a more favourable environment for pathogenic bacteria to thrive.

Resilience to the effects of GBH is calculated by the percentages of environmental pathogens and those bacteria that produce antioxidants that reduce oxidative stress, from the phyla firmicutes and including important members of lactobacillus.

How resilient is your pets microbiome to GBH

If your reading is low this means your dog has a experienced higher exposure to GBH's and has a lowered ability to protect against the effects of oxidative stress and free radical damage. Increasing dietary plant polyphenols will help to increase the existing low levels of good gut bacteria whilst reducing pathogens such as cyanobacteria and shewanella.

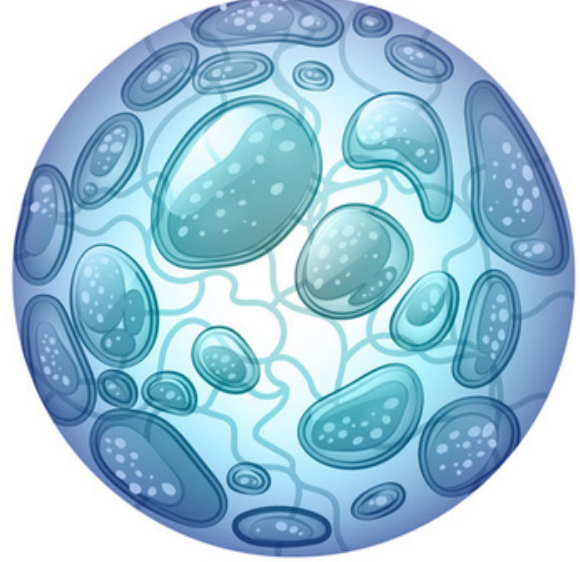
If your reading is high then this means your dog has had a lower exposure to GBH's or has a higher resilience to it's effects, a higher score is obviously preferable.



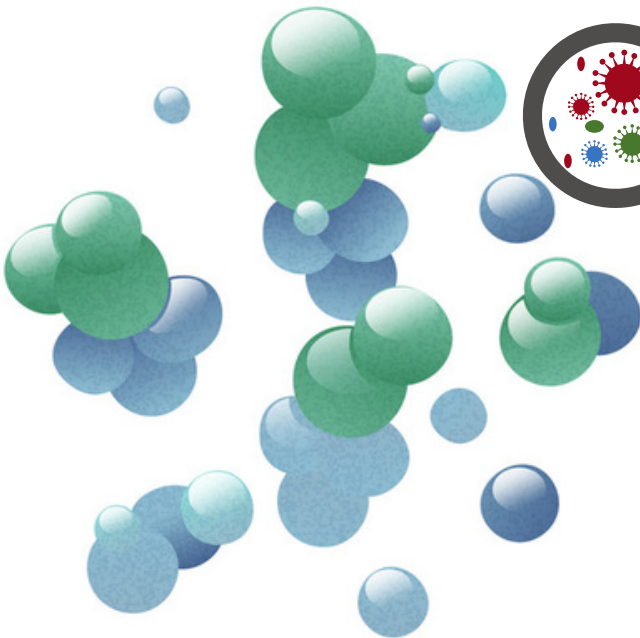
Bacteroides



Fusobacteria

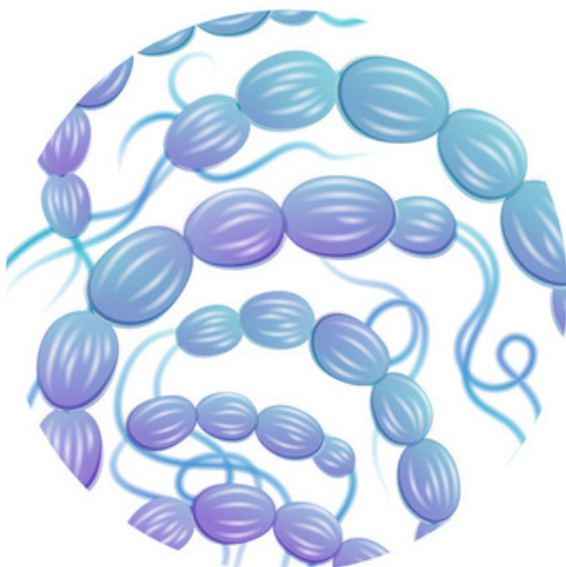


Prevotella

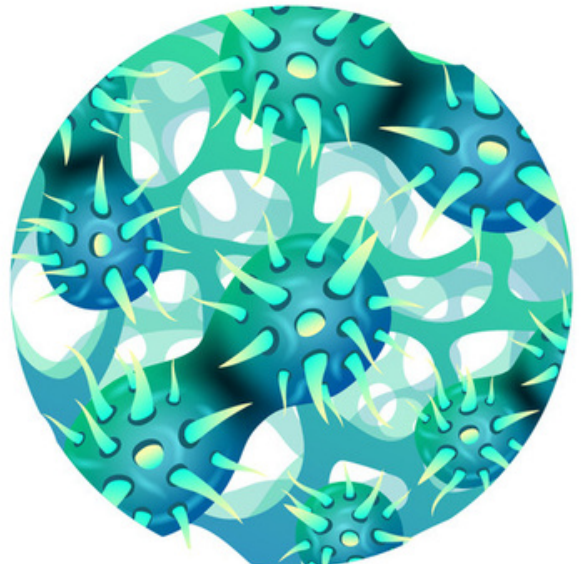


**5 Important
microbes of
the canine
gut**

Clostridia



Proteobacteria



Bacteroides

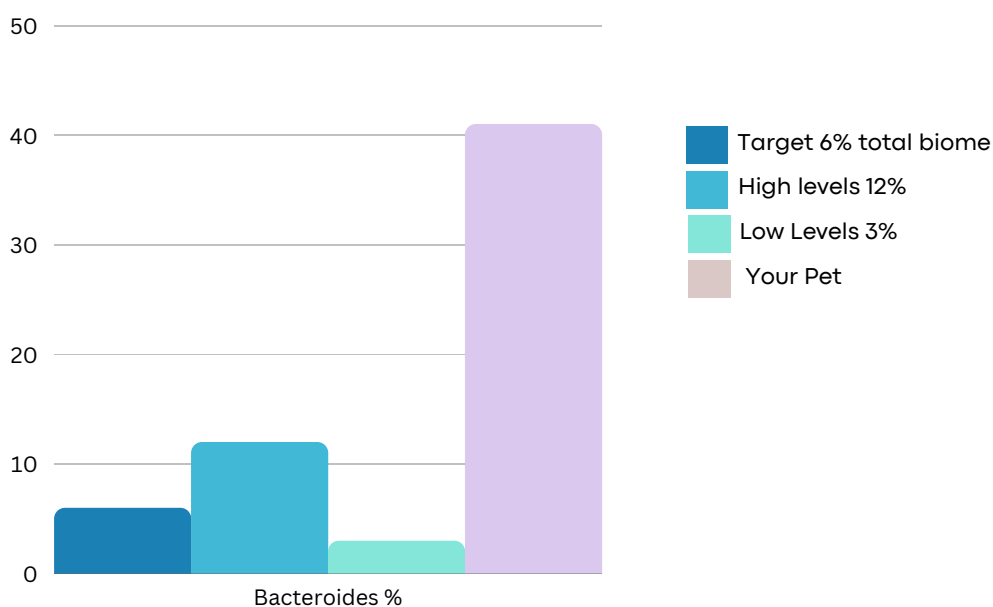
Bacteroides belong to the family that help digest carbohydrates, the recommended levels are between 4.5- 6%. When the ratio of bacteroides are too high then the dog is more likely to gain weight. If the bacteroides are too high, then your dog may be consuming too much fat and if bacteroides are too low this can reduce energy levels and ability to put on weight.

Low levels of bacteroides can also be associated with the use of long-term antibiotic or NSAID's. Administration of antibiotics that kill Gram-positive bacteria can deplete the Gram-negative phylum Bacteroides, levels can recover within a month, but in some dogs, full recovery can take up to 2 years.

Dietary Advice

A high fat diet can cause bacteroides to increase, therefore if levels are low then increase the dietary fat content and if levels are high, then reduce the fat content of the diet. If the dietary fat content is already low then feeding Petbiome Biotic Boost will help to rebalance the biome.

If levels are low, check your dog's diet for foods that contain threonine, serine, proline, and cysteine (available in meat, whole grains and cheese) these will help to produce mucin which makes the biome more favourable for bacteroides.



Fusobacteria

Fusobacteria are an important member of the healthy canine gut, being the third most common bacteria in meat eating healthy dogs.

Not much is known about the role of the phyla fusobacteria in dogs but from our population data base there are three sub division species that predominate.

The first is *Fusobacterium perfoetens* reported as being much higher in dogs that are overweight, this bacteria converts glucose to lactic acid.

Glucose as an ingredient can be listed as sugar, caramel, syrup or sucrose and found in corn/maize, wheat, sugar cane and sugar beet.

The second is *Fusobacterium mortiferum*, linked to infections and discomfort.

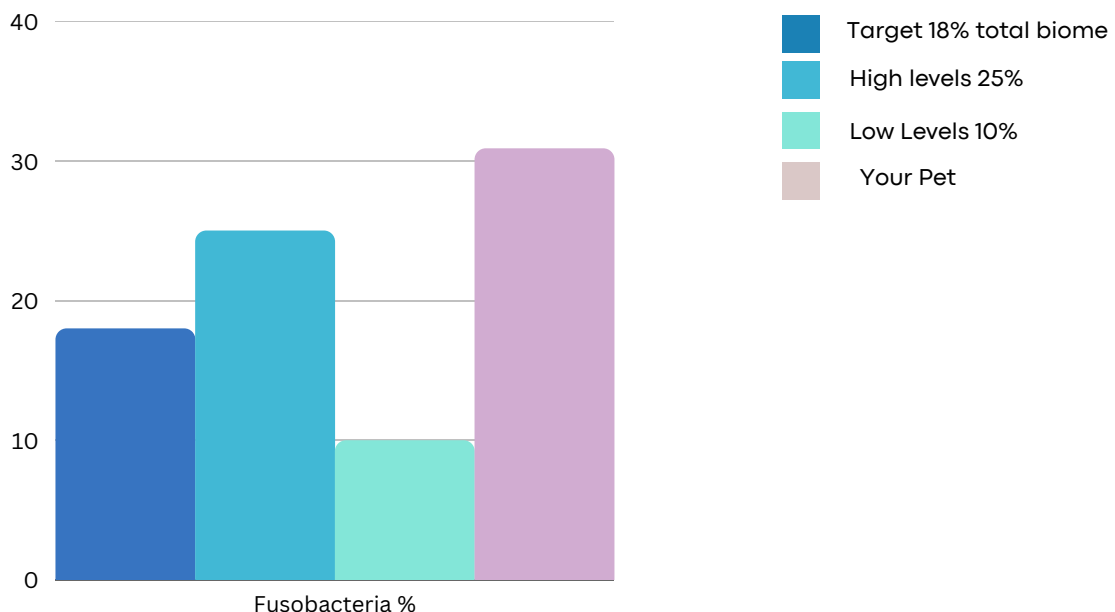
The third common component of the phylum fusobacteria is *Fusobacterium*, this genus increases in dogs with high access to the outside ie. garden, fields and parks.

Please read the veterinary summary (page 26) which will highlight imbalances between the species.

Fusobacteria gets its energy from fermenting select carbohydrates and amino acids. In low numbers it has been linked to colitis and inflammatory bowel disease. Increasing the amino acid content should help to increase levels.

Look on the food labels for the ones that aren't manufactured by the dog's own body but must be added into their daily feed. The ten essential amino acids that the diet should provide to help increase the fusobacterium are- arginine, histadine, isoleucine, lysine, methionine, phenylalanine, threonine, tryptophan and valine.

Chun, J. L., Ji, S. Y., Lee, S. D., Lee, Y. K., Kim, B., & Kim, K. H. (2020). Difference of gut microbiota composition based on the body condition scores in dogs. *Journal of animal science and technology*, 62(2), 239.



Prevotella

Prevotella are part of the normal healthy biome and contribute to the health of the dog by helping to digest carbohydrates and protein, they also produce an important supply of energy for the dog. If there is an overgrowth (high levels), these bacteria can then be linked to infections of the gastrointestinal tract.

In dogs 93% of the prevotella are identified as copri, this species increases the risk of arthritis and other inflammatory conditions. Prevotella levels increase in diets high in complex carbohydrates but low in protein. Slightly increasing the complex carbohydrate content of the dog's diet should help raise Prevotella and improve overall glucose metabolism.

Prevotella is considered to be a biomarker or measure of how much fibre is in the diet, but when levels that are too high, there is a link to inflammation.

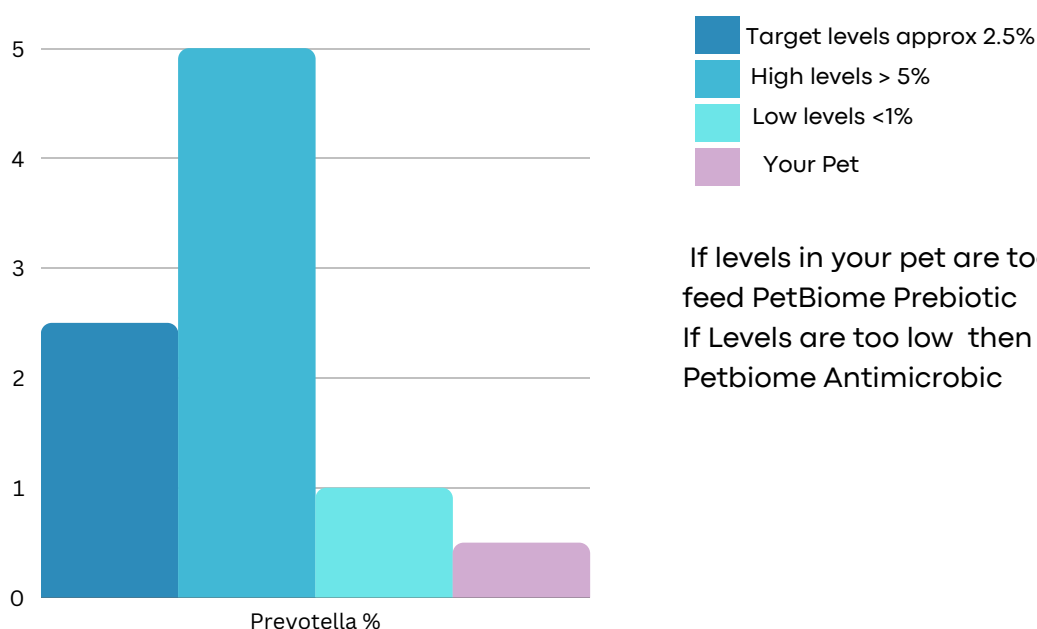
The prevotella/bacteroides ratio is important as when both are at target levels the carbohydrate/fibre intake of the dog is considered to be balanced

Prevotella helps to breakdown protein and fibre in a diet. If present in high numbers they can become opportunistic pathogens.

Dietary Advice

If levels are too low then increase the fibre part of the diet, avoid processed fibre listed as cellulose powder on the ingredient list. Cellulose, hemicelluloses, and lignins from the skins of fruit or vegetables are examples of insoluble fiber. They are not digested and pass through the gut essentially unchanged.

Complex carbohydrates also help to increase Prevotella, found in many formulated dog foods, include unprocessed grains, oat bran, hulls of brown rice, and beet pulp or prebiotics containing arabinoxylan. Avoid 'grain-free' feeds as these contain carbohydrates such as tapioca, sweet potatoes and potatoes but don't have the type of complex carbohydrates required. (Neyrinck et al 2011)



If levels in your pet are too high
feed PetBiome Prebiotic
If Levels are too low then feed
Petbiome Antimicrobic

Clostridia

Clostridia are a very important component of the biome, the recommended average is 15%. Class clostridia, from the phyla firmicutes, contain many different species of bacteria, of which a few are pathogens (botulin), overgrowths are linked to diseases such as acute hemorrhagic gastroenteritis .

The majority, however, are very host friendly. Clostridia form part of the biome 'police force' defending the gut wall barrier against invading bacteria, they also signal for an immune response and interact with other bacteria within the biome, releasing friendly feel-good chemicals to help bond the microbial community.

Clostridia help initiate an immune response in many parts of the body but one of the most important is the link to respiratory health through a shared mucous membrane along the gut/lung axis.

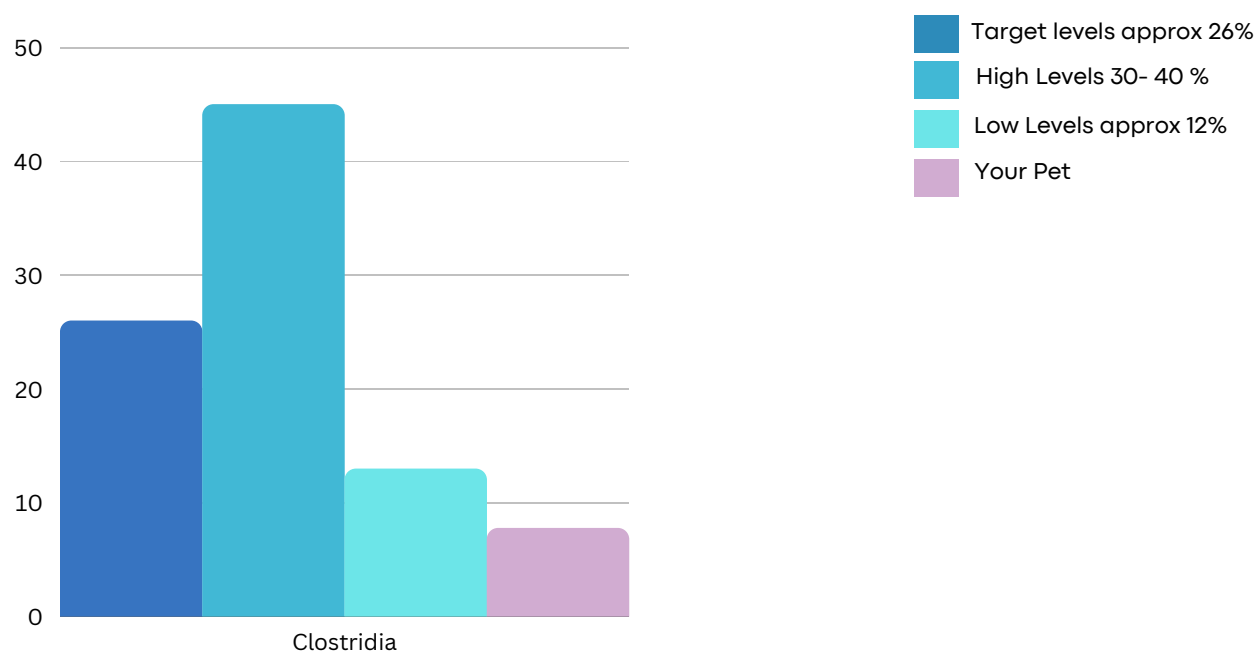
Dietary Advice

High Levels

Some members within clostridia increase in infections and illness (c. difficile, botulin) if your pet has symptoms of discomfort or infection, please check with your vet. Adding Biotic Boost to the diet should lower them.

Low Levels

Plant chemicals (antioxidants) can be used to increase the percentage of clostridia, these work by making the microbiome more favourable for clostridia members whilst reducing the bad bacteria that can make the biome more acidic and less favourable. Adding the Petbiome Prebiotic helps increase the levels of good clostridium above the bad members of the clostridia family. Rebalancing clostridia is important as your pet will have a reduced immune response and less protection against gastrointestinal discomfort and disease.



Proteobacteria

Proteobacteria are part of the core microbiome of healthy dogs, they are more abundant in dogs fed a high protein diet. Proteobacteria contain several known pathogens associated with gastrointestinal imbalances, disease, and discomfort in dogs. Including *Escherichia coli/shigella*, *Campylobacter jejuni*, *Klebsiella pneumoniae*, *Salmonella typhimurium*, and *Yersenia enterocolitica*. Clinically healthy dogs and cats do have *Helicobacter* species though at levels of less than 0.5% of the microbiome. Overgrowths or ‘blooms’ of proteobacteria are associated with dysbiosis, published research indicates dogs with gut inflammation and metabolic disorders do have higher levels.

If your dog has an overgrowth of any pathogenic member of the proteobacteria phyla this will be highlighted on the veterinary notes page.

Proteobacteria are involved in the metabolism of protein and are higher in dogs fed high protein diets, and those containing highly processed ingredients, such as soya and rice meal.

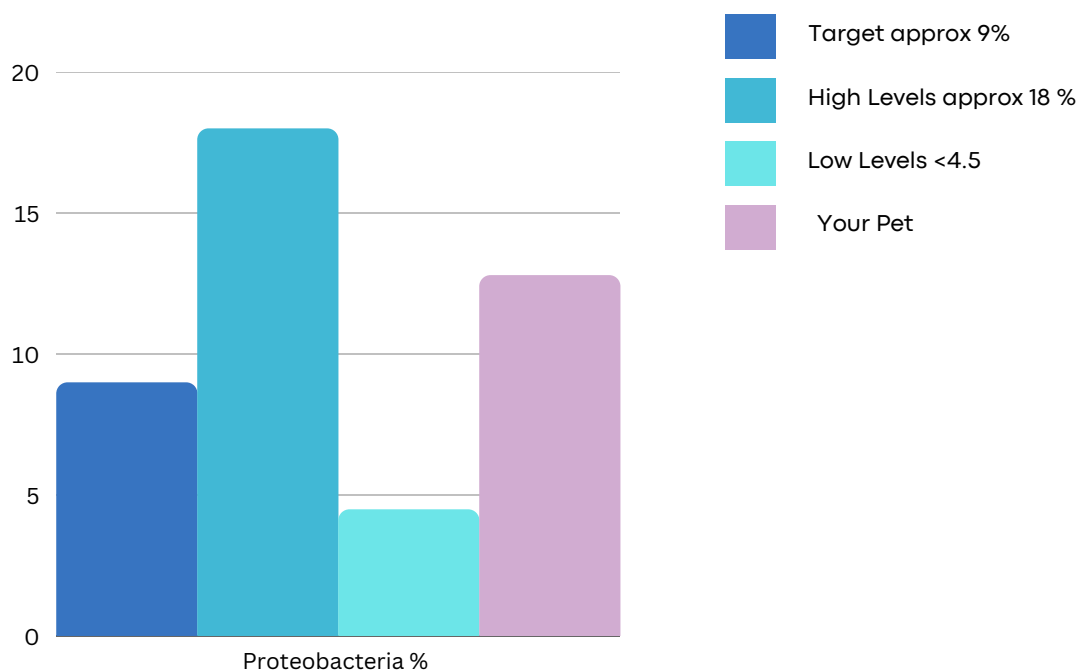
Dietary Advice

If levels of proteobacteria are high check the protein content of the diet, some types of dog food can contain as high as 22% protein. To reduce proteobacteria, reduce the dietary protein content down to 8%.

If levels are low then increasing the protein content should help.

Garcia-Mazcorro, J. F., Dowd, S. E., Poulsen, J., Steiner, J. M., & Suchodolski, J. S. (2012). Abundance and short-term temporal variability of fecal microbiota in healthy dogs. *Microbiologyopen*, 1(3), 340-347.

Moon, C. D., Young, W., Maclean, P. H., Cookson, A. L., & Bermingham, E. N. (2018). Metagenomic insights into the roles of Proteobacteria in the gastrointestinal microbiomes of healthy dogs and cats. *Microbiologyopen*, 7(5), e00677.



Health of the gastrointestinal tract and links to disease.

The gut bacteria help to protect against gastric inflammation, directly or indirectly by converting bile acid to more gastric friendly components.

Every common gastrointestinal disorder (IIBD, colitis, diarrhea) can be linked back to the microbial community. Microbe health and microbial balance is therefore a critical component for preventing gastric diseases and supporting health.

Beneficial Super Bugs contribute significantly to the overall health of the gastrointestinal tract, they do this in two ways

1. By controlling pathogenic bacteria linked to disease.
2. By preventing the development of gastric ulcers in the stomach.

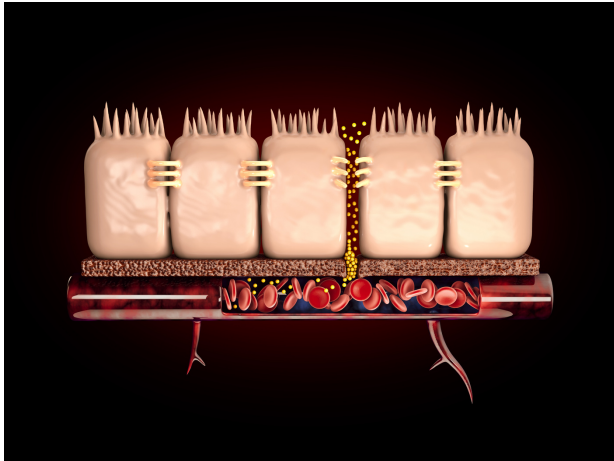
As an example, *Clostridium Butyricum* (commonly used as a probiotic against gastric infections) release anti-inflammatory, antioxidant and analgesic chemicals which provide protection against the occurrence/recurrence of gastric ulcers.

Oxidative stress is a main contributor to the development of gastric mucosa lesions, in clinical trials (Wang 2015), pretreatment with *Clostridium Butyricum* reduced oxidative stress more effectively than Omeprazole. The activity of SOD with the pretreatment of *C. Butyricum* is higher than with the treatment of omeprazole, (Superoxide dismutases or SODs account for an extremely important antioxidant defense against oxidative stress).

Clostridium hiranonis, is a species associated with normal bile acid, *hiranonis* helps to restore the gut wall and the depth of the mucin layer. It also reduces pathogenic and biome film bacteria that attack the tight junctions, allowing pathogens to translocate across the gut wall where they cause disease within the host.

It is linked to bile acid metabolism which is an important pathway for lipid digestion and control of inflammation which is altered in chronic gastrointestinal disease.

Gut Wall Integrity and Renewal

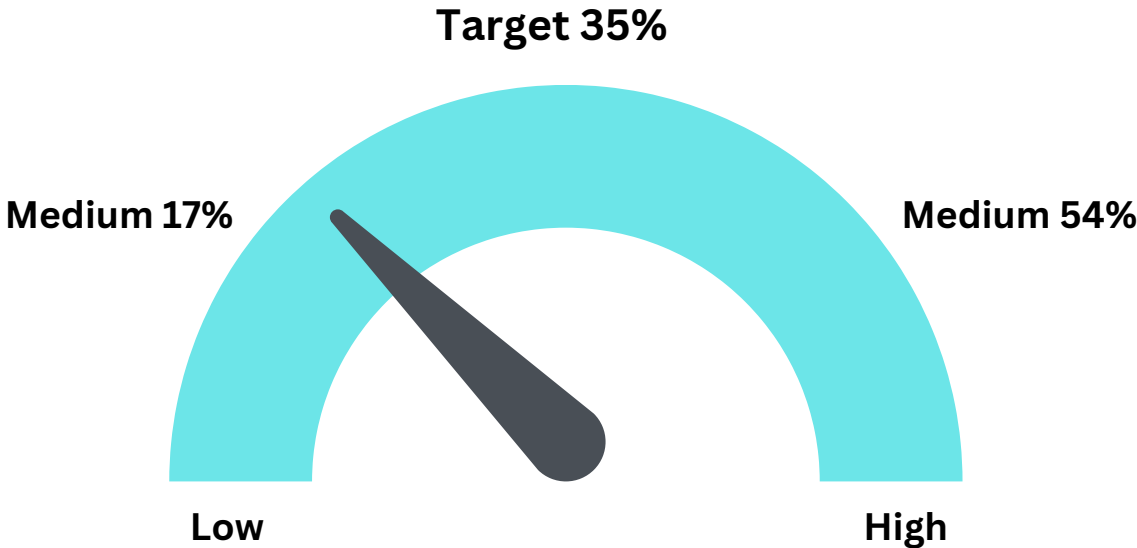


Members of this group
Lactobacillus,
Actinobacteria,
Roseburia,
Bifidobacteria

The members of this group of bacteria help to renew and maintain the tight junctions of the gut wall, a sufficiency makes the gut stronger and healthier, the target is that members of this group are present in the biome at 35%. The gut wall exists to protect the inside of the dog from any outside environmental or bacteria invaders that may cause ill health. Some bacteria are pathogenic and can cause disease if allowed to translocate or travel across a compromised gut wall.

The gut bacteria in this group are also part of the control mechanism that exists between the gut and the brain. Low numbers of bifidobacterium and lactobacillus are directly linked to biome stress, with further links to stress related conditions such as anxiety and IBD.

Many dogs are low in bifidobacterium and lactobacillus and there are many over the counter products available containing both together.



More on the Health of the Gastrointestinal Tract

Biofilm bacteria form when there are too few of the superbugs which act as a 'police force' which protect against formation.

Biofilm Bacteria

Most bacteria reside in a fixed area as part of a biofilm community, for protection and an improved chance of survival, though biofilm formation is implicated in many chronic disease states. Biofilm bacteria commonly reside in the gut wall and aggravate/cause 'leaky gut'. Colonising gut bacteria tend to rob the host of nutrients, reduced levels of good gut bacteria linked to a strong immune response and produce toxins linked to inflammation.

Risk levels for discomfort have been calculated by first identifying the number of biofilm bacteria and comparing this to the number of existing protecting/policing bacteria able to control and reduce numbers. A low risk indicates a high percentage of the good gut bacteria that provide protection. A high risk is an indication of too few good gut bacteria with high numbers of biofilm forming bacteria in the gut wall.



High

Low

High (red) indicates a higher risk of biofilm bacteria formation with links to gastric inflammation. Low (green) indicates a lower risk of biofilm bacteria with higher numbers of good gut bacteria.

Skin Allergies

The dog has a different microbial community residing on the skin and in the ear, urinary and respiratory tracts, the different sites are ecosystems each with a common core membership.

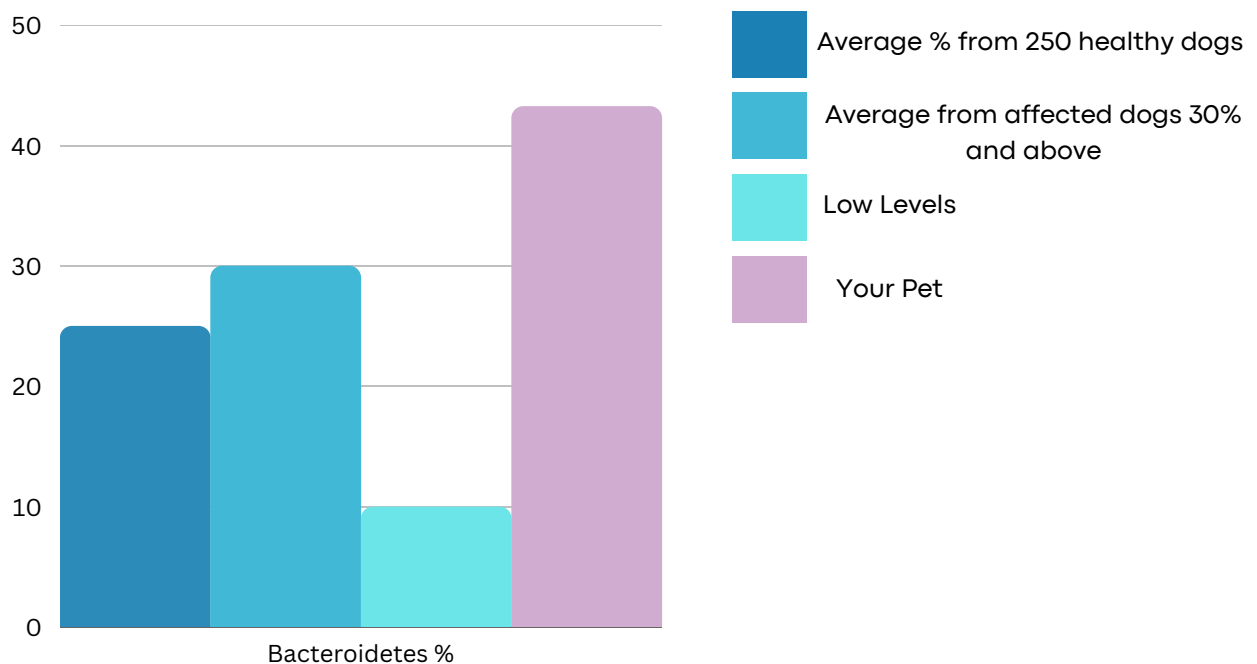
Microbes are sensitive to change and imbalances are common, causing infections and inflammation both at site and within the gastrointestinal microbial community.

Put a different way, diseases (including itching and allergies) of the skin can be linked back to gastric disturbances and imbalances through the skin/gut axis, the gut bacteria communicating through the endocrine, immune, and nervous systems.

The gut microbes are linked to many different types of inflammation including pruritis (Itching) and one of the main features is a loss of alpha diversity (species richness) especially within the phyla bacteroidetes.

The main cause for a reduction in alpha diversity is thought to be the wide use of medication such as antibiotics which reduce the numbers of predator bacteria that kill pathogenic bacteria linked to disease, such as Escherichia Coli. In the absence of predator bacteria, the pathogenic bacteria multiply and translocate across the gut wall to cause problems in other parts of the body or produce inflammation and reduced immune response. See page 9 for diversity score.

As diversity decreases the microbiome becomes more favourable for the overgrowth of bacteria linked to allergies.



The risk of developing allergies is calculated from allergen linked bacteria present in the microbiome of your pet based on our own population data of dogs with allergies/itching. A low/medium diversity score (page 7) often increases the risk of developing allergies.

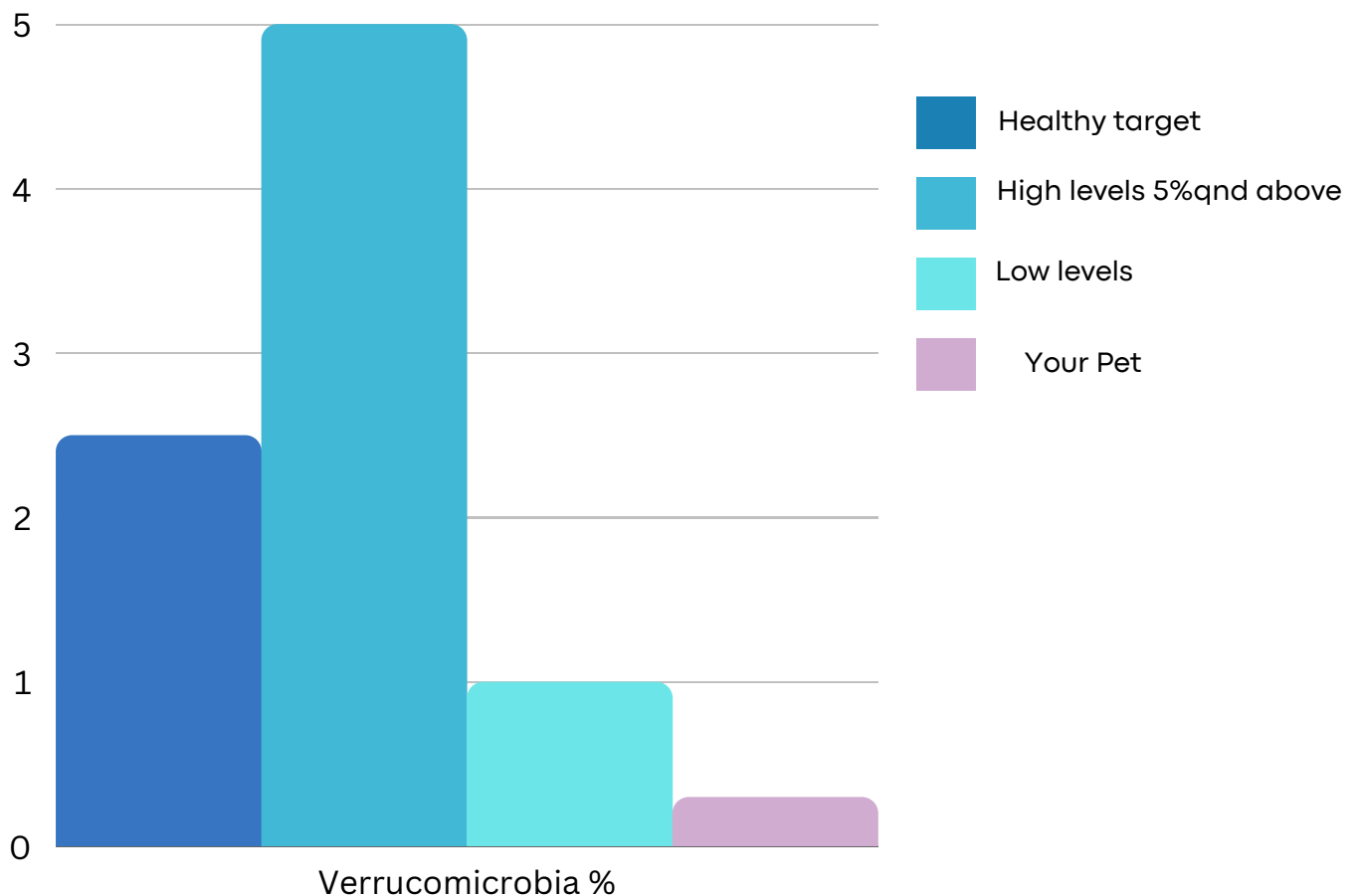
Metabolism

Verrucomicrobia Akkermansia levels relate to efficient glucose metabolism and has been calculated (from our own population data) to be 2.5- 3%, low levels indicate a sluggish/poor glucose metabolism in the gut. Low levels of Verrucomicrobia Methyacidaphales relate to a reduced insulin/GLP -1 function. Akkermansia is considered to be a good measure of a healthy biome it is directly linked to insulin sensitivity. It is also an important anti-inflammatory, helps repair the gut wall, and has a direct relationship with the immune system.

Low levels of V. Akkermansia are common and may contribute to ill health associated with metabolism including weight gain/obesity.

Gut bacteria can play a role in preventing weight gain through the digestion of food and selection and absorption of nutrients, one of the main components of weight gain is a loss of biodiversity and a reduction of the number of species associated with leanness.

Following several years of research into the microbial communities living within the gastrointestinal tracts of overweight/obese dogs, the PetBiome Prebiotic Plus contains the nutrients and active plant compounds that help select and feed the bacteria within this group.

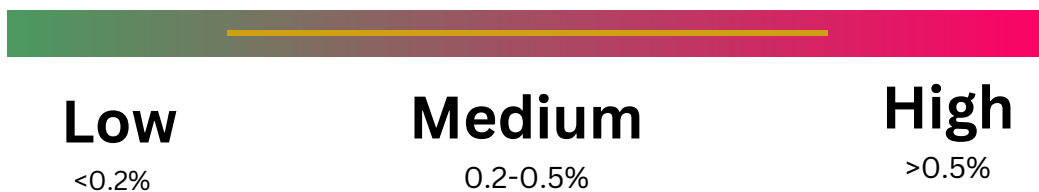
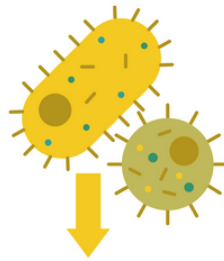


Bloating

Methanogens that produce methane gas are not “bacteria” but belong to the Archaea kingdom.

Syntrophy is a term used to describe the relationship between two bacteria that help to feed each other and maintain a favourable environment to ensure each other’s survival. Methanogen archaea have a syntrophic relationship with other microbiota, converting CO₂ and H₂ to CH₄, they also produce short-chain fatty acids (SCFAs) from carbohydrate, which contributing to 10% of the host’s daily energy requirements. One of the main roles of methanogens is to maintain the hydrogen gas balance in the gut, alterations (too many or too few) may increase the risk of gut dysbiosis/disease.

Your Dogs Methanogen Score



Happy Chemicals

Dogs can be aggressive for different reasons, aggression being categorised in relation to dominance, fear, food and territorial.

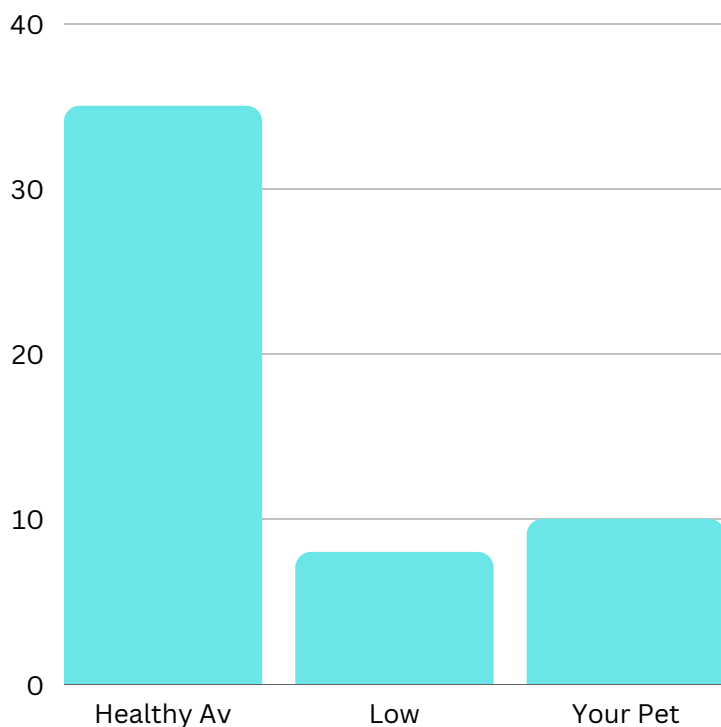
There is also a 5th category, recently identified by science and linked to the microbiome of the dog which may be more common and relates to gut microbiome imbalances (called dysbiosis), this type of imbalance can also include anxious (phobic) behaviour.

Here's how it works.

The gut bacteria communicate with the brain by making chemicals that send signals or cause reactions in the nerves and hormones. This connection is called the gut/brain axis. The brain uses 3 key chemicals in relation to mood, a high proportion of all three are produced solely by the gut bacteria, mood changes are therefore easily influenced or changed by the members of the microbial community.

- Serotonin, seventy percent of the 'happy chemical' is produced in the gut affects mood and anxiety levels.
- Dopamine, fifty percent is manufactured in the gut.
- GABA, microbes use putrescine and glutamate to produce GABA which regulates stress and anxiety.

Full metagenomic sequencing is the best way to analyse whether the gut is producing enough of the 'happy chemicals, using an algorithm to calculate levels of chemicals being produced.

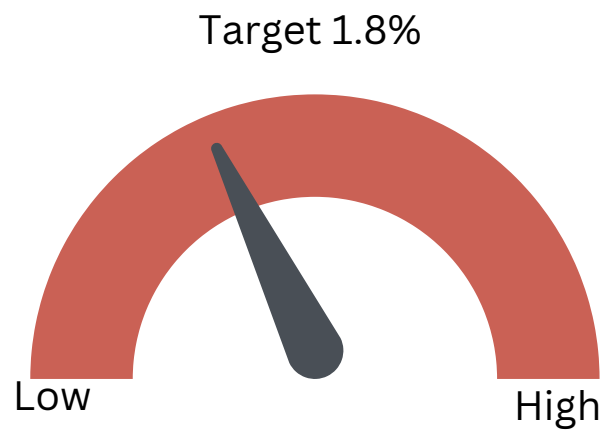


In a healthy microbiome 35% of the inhabitants would be involved in the production of happy chemicals. If your pet is too high or too low the Petbiome Prebiotic Plus will help to restore balance.

Temperament

Anxious Phylogenetic Type

Both of these bacteria are linked to good health and temperament, low levels are indicative of an anxious phylogenetic type. It is possible to supplement with a live probiotic for both species or alternatively consider a faecal transplant from a healthy/calm donor.

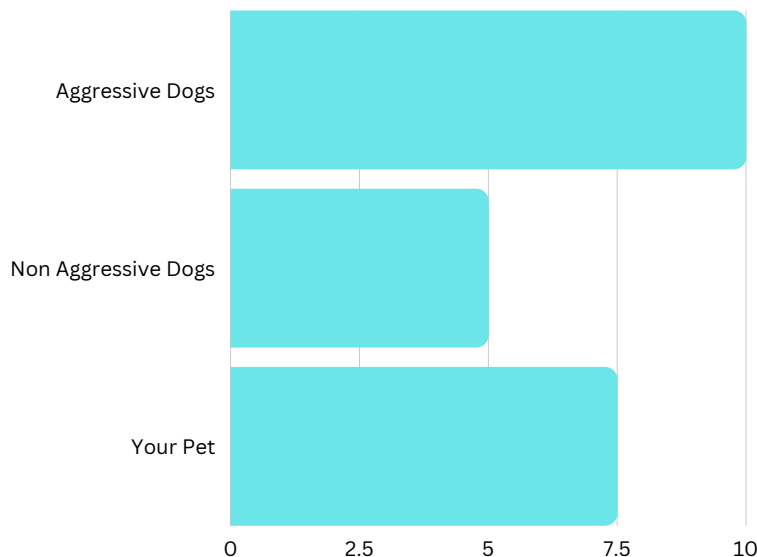


Aggressive Phylogenetic Type

Higher percentages of the bacteria within this group (Lachnospiraceae, Erysipelotrichaceae and Clostridiaceae) at 10% or higher are indicative of greater aggression.

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Mondo, E., Barone, M., Soverini, M., D'Amico, F., Cocchi, M., Petrulli, C., ... & Accorsi, P. A. (2020). Gut microbiome structure and adrenocortical activity in dogs with aggressive and phobic behavioral disorders. *Heliyon*, 6(1), e03311

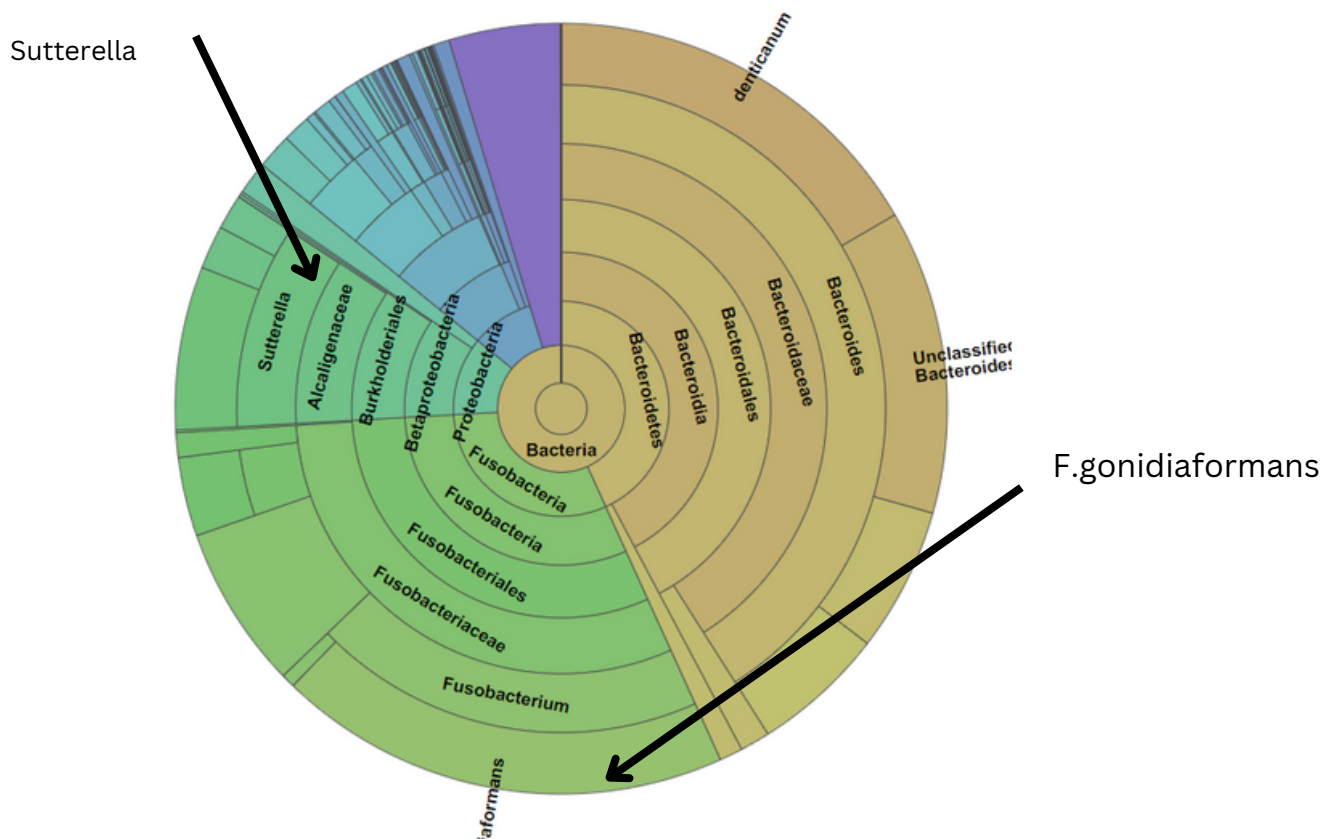


Vet Summary

This dog has 30% of the biome made up of two pathogens associated with inflammation.

Sutterella makes up 10% and *F. gonidiaformans* are often associated with mixed intra-abdominal infections, perirectal abscesses, osteomyelitis, decubitus, and other ulcers and various soft tissue infections.

There is also a loss of diversity within the bacteroidetes, the species that are present are associated with inflammation.



Thank You For Using PetBiome

We really hope you have found this report a useful tool to support the good health of your dog throughout all the stages of his life. If you would like to discuss this report in greater detail we are able to help. We offer a free 15 minute session to go through your report (please phone or email to book). For longer sessions relating to helth/diet/discomfort/ disease please book a longer session through the PetBiome shop (£45).

Please let us have feedback or contact us if you need any further info on any topic within this report.



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