Candida and Gut Dysbiosis

The Intestinal Zoo

Around 500 species of bacteria, as well as many species of yeast and other organisms, inhabit the human gastrointestinal tract and make up the "gut flora". In an average adult the bacteria weigh about 1kg and the number of individual organisms easily outnumbers the total number of cells in the human body.

Luckily for us a large number of these organisms don't cause disease, as it would be easy to assume, in fact, they help protect us from disease. The gut flora perform many functions that contribute to the health of the human host; "friendly bacteria" mostly have names beginning with 'Lactobacillus' or 'Bifidobacteria' which denotes the genus they belong to. You may have noticed food products like yogurt that contain these bacteria. It is becoming more common for them to be added, just as vitamins and minerals are frequently added to breakfast cereals, for example.

Major useful functions of friendly bacteria:

- Producing short chain fatty acids which supply a valuable proportion of human energy requirements.
- Producing a number of valuable nutrients notably B vitamins and vitamin K
- Participating in the metabolism of drugs, hormones and carcinogens
- Protecting the host from infection by pathogenic bacteria (through competing for space and production of anti-bacterial substances amongst other methods.)
- Maintaining a healthy intestinal pH
- Enhancing immune function

The friendly bacteria aren't the only type of microorganism present in the human gastrointestinal tract however. There are also a number of organisms that don't provide the human host with any benefits or do so only when their numbers are kept low by competing friendly bacteria. Such microorganisms include coliform bacteria (E.coli etc), yeasts/fungus and bacteroides.

What can go wrong?

Illness can occur when the amount of friendly bacteria is reduced and the other organisms are able to increase their numbers and become the majority. There are a number of factors that can disrupt the balance of organisms in the intestines and lead to overgrowth of the less desirable species.

The most important factors are:

- Antibiotic use
- Use of the birth control pill
- Use of other hormones, especially immunosuppressants like steroids
- Diet
- Alcohol
- Stress

Probably the most important factor is the use of broad spectrum antibiotics. These medications don't discriminate between friendly and pathogenic bacteria. This means that every time you take one of these drugs for an infection you're are wiping out large numbers of the friendly bacteria in your intestines that give protection from other, potentially harmful, intestinal residents. This fact has long been known by researchers and is taught to microbiology students.

The amount of research in this area involving human subjects, regarding Candida in particular, is limited due to a lack of agreement on accurate testing methods and the fact that it is a relatively new area of study. Testing for small bowel bacterial overgrowth (SBBO) however, is now becoming established using breath hydrogen testing. There has also been a lot of animal research showing that both antibiotics and steroids commonly cause substantial increases in Candida and pathogenic

bacterial colonization, due to destruction of friendly bacteria and suppression of immune defenses (1, 2, 3, 4).
One result of antibiotic use which is undisputed is antibiotic induced diarrhea which is thought to be caused mainly by Clostridium difficile infection, the incidence of which is on the increase (5). Recorded cases reported in March 2005 put the number of cases annually at 3 million in the United States (6). C.difficile infection is difficult to treat and severe cases can even lead to death. Treatment in the conventional medical setting involves more antibiotics, targeted at C.difficile in particular.
Until recently antibiotic drugs were seen as a magic bullet without side effects. As we can now see however, there ARE side effects that can be significant and the effects of the disturbance they cause to gut flora and overall health are only starting to be uncovered.

Candida/Yeast

Candida is a type of yeast that is one of the most common residents of the human mucous membranes such as the gut, urinary tract and vagina. In the small intestine (not the large intestine, or colon, as is often suggested) Candida and Lactobacilli are the predominant residents. The most common type of Candida is 'Candida Albicans' but other species are also widely found. Candida is a "dimorphic" organism which means that it can exist either as a round yeast cell or as a fungus (mycelial form) with spindly outgrowths called hyphae that can penetrate the body tissue of the host. In healthy individuals candida is kept in check by friendly bacteria and a healthy immune response and remains in the yeast form.
If the friendly bacteria are disrupted by any of the factors previously discussed, Candida can increase it's numbers drastically and become a more dominant member of the "intestinal zoo". When this happens it spells trouble for the human host. As Candida is a yeast, it produces alcohol (ethanol) and acetaldehyde (this is the chemical responsible for the main symptoms of a hangover) as the major products of its metabolism. In healthy individuals alcohol can be detected in the blood from exactly this source but it is at a level that doesn't cause any problems as the bodies detoxification systems can cope with it. If however you have an overgrowth of intestinal Candida, the levels of alcohol entering the bloodstream are going to be greatly increased. In a study conducted by doctors at Biolab in London, UK, a number of chronically unwell patients were tested for blood ethanol levels an hour after ingesting a sugar solution. The study found the patients consistently had high blood levels of ethanol which the researchers concluded came from small intestinal yeast overgrowth (7). To make this situation worse, when Candida has a foothold it is free to transform into the fungal form and its branching hyphae can penetrate the intestinal wall (1). This makes the intestine more permeable (Leaky Gut Syndrome) so more of the toxic alcohol and acetaldehyde are absorbed into the body. Also with a highly permeable intestine, the Candida themselves may actually be able to slip through and gain access to the rest of the body causing chronic immune reactions like allergies and autoimmune diseases.
Recent research has directly shown that antibiotics and the resulting increased Candida colonization of the intestinal tract leads to an increase in airborne allergies (4). One study showed that mice given antibiotics had increased intestinal Candida colonization, which has been shown many times before, but also showed a concurrent increase in allergic responses to an airborne mold spore called Aspergillus fumigatus. This research is very important as it shows that alteration of gut flora with antibiotics can affect immune response and lead to an increased incidence of allergies.
Other research has linked intestinal Candida to Celiac disease (8). Celiac disease is an autoimmune disease in which a T-cell mediated immune response results in damage to the tissue of the small intestine. This reaction is triggered by the ingestion of gluten, a protein found in grains, predominantly wheat, barley and rye. What the research shows is that a protein found in the cell wall of Candida is very similar to gluten. As a result, the immune system can confuse gluten found in grains for the cell wall of Candida and mount a response against the gluten. The immune cell bound gluten then damages the small intestinal wall as in Celiac disease.

Signs and Symptoms of Intestinal Candida Overgrowth

Everyone knows that drinking too much alcohol makes you feel less than great, imagine if your body is absorbing a level of alcohol a lot higher than normal, constantly, over a period of years. This is clearly going to lead to a less than optimal state of health. Nutrients will be depleted, valuable liver enzymes will become depleted, resulting in oxidative stress, due to being constantly overworked trying to

detoxify the yeast products and the yeast products themselves will also cause direct damage to multiple body systems.
As you can probably imagine, as the whole body is effectively "poisoned" by an overgrowth of Candida, the number of symptoms it can produce are vast and affect every bodily system.
Here's a short list of common symptoms:

- Fatigue
- Weakness
- Muscle & joint aches
- Headaches
- Feeling of being "hung over"
- Gastrointestinal disturbances - diarrhea, constipation, nausea, bloating after eating
- Psychological disturbances - depression, anxiety, irritability, mood swings
- Cognitive dysfunction - poor memory, lack of concentration
- Recurrent vaginitis
- Menstrual Disturbances and Infertility
- Allergies
- Skin irritations/rashes/acne
- Recurrent throat/ear infections
- Hypoglycemia

Candida in Environmental Illnesses
The symptoms above may seem very similar to those presented by CFS sufferers and sufferers of the other illnesses covered on this website. Indeed, clinical studies have hinted at the involvement of Candida in CFS (9) and other published material has hypothesized a causal link (10). It is increasingly common for doctors specializing in CFS/Fibromyalgia to treat their patients for yeast overgrowth as part of their treatment.
Research conducted in Norway and published in January 2005 suggests Candida may be a cause of irritable bowel syndrome (IBS)(11). The authors state that:
" there is increasing evidence for yeasts being able to cause IBS-symptoms in sensitized patients via Candida products, antigens and cross-antigens."
They go on to say however that more research needs to be conducted before antifungal therapy can be recommended as a first line treatment for IBS.
Candida has also been put forward by a number of sources as being involved in the etiology of autistic disorders. One leading proponent of this is Dr. William Shaw of The Great Plains Laboratory in the US. Dr. Shaw discovered elevated levels of certain organic acids in the blood and urine of autistic twin boys when he was working for the CDC.
Learn more about Candida and autism spectrum disorders

Testing for Candida/Yeast Overgrowth
Yeast overgrowth can be detected by stool sample, testing Candida antibody levels or either a urine or blood sample testing for levels of yeast products such as alcohol and organic acids. The first line of investigation used by many doctors to determine if a patient has a yeast problem is an extensive questionnaire, originally employed by Dr. William G. Crook.
Click here to view the Candida/yeast Questionnaire
Most doctors still refuse to admit that candida can cause illness due to intestinal overgrowth but this is changing as the research suggesting otherwise continues to grow. Even a major medical institution like the CDC now mentions it on their website; this statement is from a CFS related page:
"Candida albicans: A common saprophyte* of the digestive tract and female urogenital tract. It does not ordinarily cause disease, but may do so following a disruption of bacterial flora of the body, or in patients with depressed immune systems."
*"An organism, especially a fungus or bacterium, that grows on and derives its nourishment from dead or decaying organic matter."

Most official medical institutions issues statements such as:
The authors continue: “Although the increase in Candida colonization associated with the use of antibiotics, particularly broad-spectrum ones, is well established, there is no proof that this results in the production of Candida toxins....– the hypothesis of ‘chronic candidiasis’ must be considered speculative and unproven.”
They would appear to be simply covering their backs in the absence of what they would call "definitive" proof. The suggestion that they accept substantial yeast overgrowth but not the production of toxins seems ridiculous. The major products of normal yeast metabolism (ethanol and acetaldehyde) are well known toxins that cause serious damage to living tissue. With this in mind, an increase in yeast colonization will undoubtedly lead to an increase in production of toxins and at some point, disease as a result.
The main factor that is hampering efforts to determine the role of intestinal yeast in disease is the lack of agreement over a definitive diagnostic test for intestinal yeast overgrowth. Stool samples are often unreliable as positive results do not always correlate with symptoms and the reverse can be true with negative results found in a clearly symptomatic patient who has many other factors pointing at yeast overgrowth.
This situation has hampered research efforts and understanding for a long time now. A solution may be on the horizon however as recent research has strongly suggested that D-arabinitol may be a candidate for this definitive marker of intestinal yeast overgrowth (12, 13). D-arabinitol is a 'sugar alcohol' produced by yeast when they feed on a sugar called arabinose. If there is a yeast overgrowth in the intestines this substance will be absorbed and be detectable in the blood and urine.
Until a definitive diagnostic test is developed, it is wise to look at evidence from different sources. Stool, antibody and organic acid tests along with the yeast questionnaire will give a good idea of whether you have a yeast overgrowth or not, especially when used together.
You can learn more about these tests on our lab tests page.
To learn about the treatment options for Candida overgrowth visit our anti-fungal treatment page

Bacterial Dysbiosis
Bacterial dysbiosis results from the same situation as Candida overgrowth, namely disruption of normal intestinal flora by the the various factors mentioned previously. When the normal balance of organisms in the intestines is disturbed, potentially pathogenic bacteria are able to thrive. Common bacterial infections found on CDSA tests include klebsiella and proteus species as well as various strains of e.coli. It should be noted that doctors who routinely use diagnostic tests such as CDSA's and organic acid testing often find evidence that Candida and bacterial overgrowth are both present in the same patient.
According to Dr. Leo. Galland, a New York physician specializing in gut dysbiosis, there are 4 distinct types that can occur, these being:

1. Putrefaction
2. Fermentation
3. Deficiency
4. Sensitization

Putrefaction
Putrefaction dysbiosis results from diets high in fat and animal flesh and low in insoluble fiber which increases transit time and allows ingested material to putrify in the colon. This results in an increased concentration of Bacteroides species and a decreased concentration of Bifidobacteria species (friendly bacteria) in the stool. The change in composition of the gut flora leads to an increase in bacterial enzymes which amongst other things can increase cancer causing substances, play a role in inflammatory bowel disease (IBD), cause diarrhea and interfere with the body's hormones (14, 15, 16, 17). As there is a decrease in friendly bacteria, the production of short chain fatty acids and other beneficial nutrients is decreased. There is also an increase in ammonia which can have negative effects on numerous bodily functions, especially liver/detoxification pathways and brain functions. Research has implicated this type of dysbiosis in contributing to colon cancer and breast cancer.

Fermentation/Small Intestinal Bacterial Overgrowth (SIBO)
This type of dysbiosis is commonly referred to as Small Intestinal Bacterial Overgrowth or SIBO. This is due to the fact that it involves overgrowth of bacteria in the small intestine rather than the colon. The result is the same type of problem as with yeast overgrowth (also predominantly in the small intestine) whereby the sufferer develops an intolerance to carbohydrate. Any carbohydrate ingested is fermented by the bacteria and results in production of toxic waste products such as organic acids (acetic acid, lactic acid etc) and hydrogen sulphide (H2S), all of which are potentially toxic in increased amounts and can lead to acidosis. The bacteria also compete with the patient for nutrients, potentially leading to malnutrition, and may also damage the cells of the intestine (18). A study at Biolab Medical Unit in London, UK, found that patients with increased gut fermentation also had increased intestinal permeability, also known as leaky gut syndrome (19). These findings have also been replicated elsewhere (20).
Typical symptoms of SIBO include:

- Diarrhea
- Anemia
- Weight Loss
- Malnutrition
- Flatulence
- Abdominal Pain

It is likely, due to the increased production of organic acids and other metabolites that end up in the circulating blood, that SIBO can cause a much wider range of systemic complaints, as suspected with Candida overgrowth, but these are obviously much more difficult to document.
Unlike Candida overgrowth however, a reliable test is available to diagnose SIBO. The test is known as the breath hydrogen test and measures the amount of hydrogen on a patient's breath a specified amount of time after they have ingested a sugar solution. An elevated level of hydrogen indicates an overgrowth of bacteria in the small intestine. The breath hydrogen test is now in common use and has been used in multiple published studies (21, 22, 23).

Deficiency
Use of antibiotics or a diet low in soluble fiber may create an absolute deficiency of normal gut flora, including Bifidobacteria, Lactobacillus and E. Coli. As a result of deficiency the human host will be deprived of the nutrients usually supplied by the gut flora and deficiencies may result. There will also be weakening of the immune system and hence a reduced resistance to infection. Deficiency has been linked to Irritable Bowel Syndrome (IBS) and food intolerance. Deficiency and putrefaction dysbiosis often occur simultaneously.

Sensitization
Sensitization dysbiosis refers to a condition where there is an increased immune response to the normal gut flora. This situation may be associated with the development of inflammatory bowel disease, spondyloarthropathies, other connective tissue disease and skin disorders like psoriasis or acne. One study at King's College, London, UK, found that IBD patients produced a higher than normal number of IgG antibodies in their intestines and that these antibodies were directed against the intestinal bacteria (24). The immune system may be overreacting to the bacteria themselves, or substances produced by them. Intestinal bacteria may play a part in autoimmune diseases as the immune system first reacts to bacterial antigens and then cross reacts with the body's own cells with a similar protein structures. Sensitization and fermentation types of dysbiosis may go hand in hand, just as deficiency and putrefaction do.

Bacterial Dysbiosis in Environmental Illness
The most extensively studied connection is between SIBO and allergic illnesses such as asthma and eczema, particularly in children. There is an increasing awareness of the importance of the gut flora to the health of the immune system and to the body as a whole, this is reflected in the vast amount of research published in this area in recent years. The general consensus is that the gut flora interact

directly with the immune system and that disturbances in the gut flora leads to an increased incidence of allergic diseases (25, 26, 27). In fact the gut flora is the major factor involved with the development of the immune system after birth. Abnormal gut flora has been repeatedly found in babies and young children with allergic diseases and the administration of healthy Lactobacilli bacteria have been shown to prevent development of these same diseases (27).

By far the most common type of bacterial dysbiosis associated with environmental illnesses is excessive fermentation type or small intestinal bacterial overgrowth (SIBO).

There have been multiple studies implicating SIBO in irritable bowel syndrome, chronic fatigue syndrome and fibromyalgia (28, 29, 30, 31).

One study published in the Journal of the American Medical Association (JAMA), one of the world's most prestigious journals, concludes that SBBO likely plays a major role in the disease process of IBS (31). The study says:

"The possibility that small intestinal bacterial overgrowth (SIBO) may explain bloating in IBS is supported by greater total hydrogen excretion after lactulose ingestion, a correlation between the pattern of bowel movement and the type of excreted gas, a prevalence of abnormal lactulose breath test in 84% of IBS patients, and a 75% improvement of IBS symptoms after eradication of SIBO"

In conclusion the study authors state that the gastrointestinal and immune effects of SIBO provide a possible explanation for the multiple gastrointestinal and non-gastrointestinal symptoms of IBS.

SIBO has also frequently been seen in chronic fatigue syndrome patients. One review of published literature states that amongst other things, CFS patients " have marked alterations in microbial flora, including lowered levels of bifidobacteria and small intestinal bacterial overgrowth" (28).

Interestingly, a study published in 2004 found that SIBO is more common in fibromyalgia patients than in IBS patients (30). This result was based on the amount of hydrogen detected with hydrogen breath testing after a lactulose solution was ingested. An important aspect of this study that should be noted is that the severity of SIBO detected in fibromyalgia correlated with the amount of tender point pain the patient was suffering, so there is clear evidence of a connection there. Pain levels were assessed with patient questionnaires.

Finally, the link between intestinal health and mental health is starting to be investigated. Research is showing that nutritional influences on depression are currently underestimated and that depressive patients have altered gastrointestinal function, increased oxidative stress, altered immune function and deficiencies of various nutrients, omega-3 fatty acids in particular (32). SIBO is suggested as a reason for the decreased nutrient status and stress is known to have a negative impact on gut flora, reducing numbers of the beneficial Lactobacilli and Bifidobacteria species. Further research is needed to look directly for SIBO in depressive patients.

It is likely, as knowledge of the roll of gut flora in health expands, that dysbiosis will be found to be involved in many more illnesses, but until then we have a lot to think about with what has already been discovered.