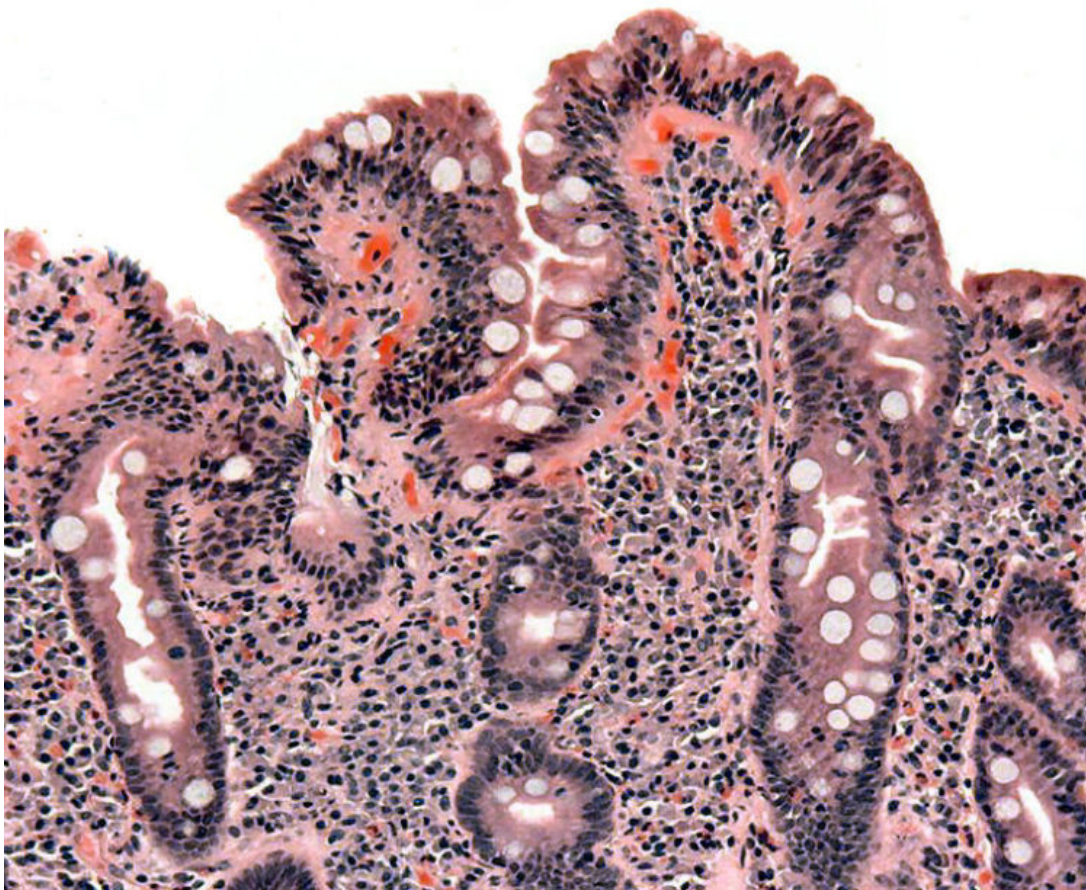


Small Intestinal Bacterial Overgrowth (SIBO) — Symptoms and Treatment

[See online here](#)

Our body is able to make use of the metabolic sources in the environment by way of the alimentary tract. In order for it to serve as a conduit for the food and other essential substances, it has to undergo specific functions such as food propulsion, secretion of digestive juices, and absorption of simplified nutrients and vitamins, among others. Needless to say, any interruptions in the continuity of any portion of the digestive tract would result in a lot of problems, including absorption. Small intestine bacterial overgrowth is an example of a condition that could result in malabsorptive conditions.

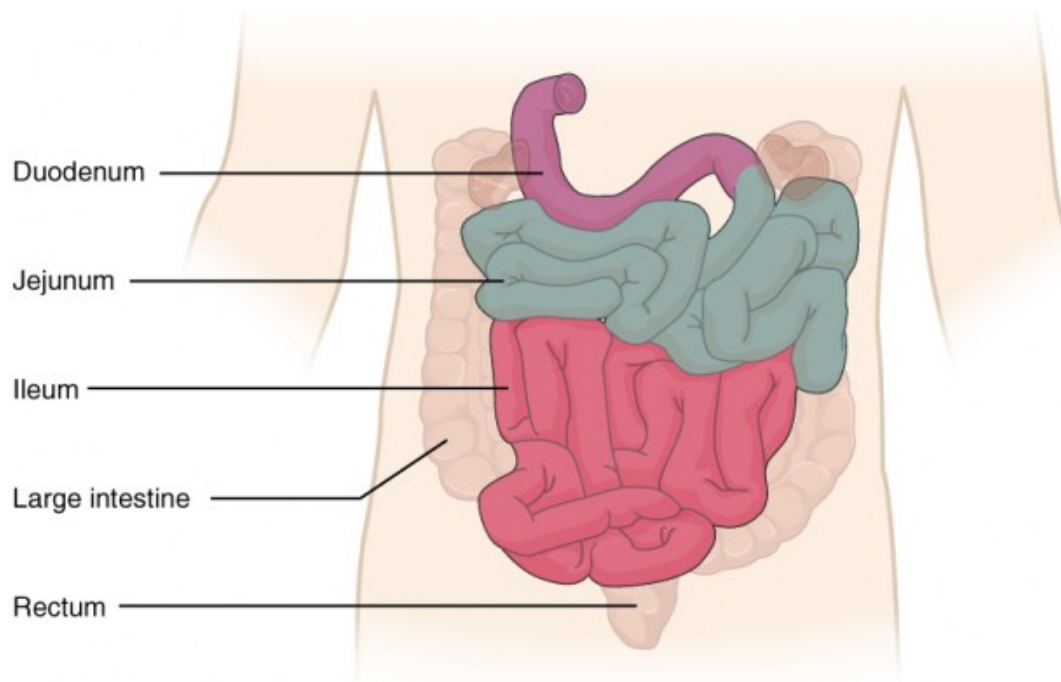


The Small Intestine — Anatomy, Physiology,

Histology

The [small intestine](#) provides the bulk of the absorptive capacity of the digestive system. Aside from being able to mechanically digest food and facilitate chemical digestion, it contains structures that allow it to **transfer the nutrients from the external environment into the bloodstream**.

Anatomy of the small intestine



[Image](#) "The three regions of the small intestine are the duodenum, jejunum, and ileum." by philschatz. License: [\(CC BY 4.0\)](#)

This **continuous muscular tube** extends from the end of the pyloric sphincter of the [stomach](#) to the area right before the cecum of the large intestine. It measures around 20 feet from end to end and is divided into 3 regions:

1. **Duodenum**, a C-shaped structure that receives chyme from the stomach. It is where pancreatic secretions and bile are released. These substances aid in the digestion of fats, proteins, and carbohydrates
2. **Jejunum**, which is separated from the duodenum by the **suspensory ligament of Treitz**. This portion primarily absorbs all the nutrients from the food. Its efficiency is improved as the surface area of this absorptive portion is increased by **plicae circulares**.
3. **Ileum**, which absorbs the nutrients left in the digested foodstuff from the jejunum. It is the area where bile acids are reabsorbed and recycled back into the liver. Problems in this area also result to B12 absorption problems.

Physiology of the small intestine

Although directly receiving highly acidic chyme from the stomach, the duodenum is able to remain intact with the help of **bicarbonate secretions** coming from the cells composing its lining and from the [pancreas](#). As mentioned before, this area serves as the

mixing vessel for the potent digestive substances from the pancreas and **liver** such as:

- Trypsin, chymotrypsin and carboxypeptidase – digest proteins
- Bile salts and lipase – emulsify and digest lipids
- Amylase – digests carbohydrates

Just like the stomach, the small intestine is capable of mechanically digesting food with the help of its muscular layers. These layers work together in order to bring about **segmentation** that “chops down” food as it passes through the lumen. The layers are the following:

- Inner circular layer
- Outer longitudinal layer

Since the small intestine serves primarily as an **absorptive structure**, it makes sense that it is lined with **columnar epithelial cells** that allow for either passive diffusion or active transport of nutrients from the lumen into the bloodstream. As noted above, the surface area of the intestines is increased by the plicae circulares.

In addition to this, these folds in the inner surface of the intestines are lined with finger-like **villi** which increase the surface area even further. These structures are essentially made up of cores of lamina propria that are lined with simple columnar epithelium. Moreover, even the individual columnar epithelial cells in the lining have **microvilli** that contribute to the surface area as well.

Inside a villus is a central lacteal and numerous capillaries that act as conduits for the absorbed nutrients. The nutrients absorbed via the hematologic route passes through the liver via the portal circulation where it is metabolized or prepared for storage.

Histology of the small intestine

Some histologic facts about the intestines are already mentioned under anatomy and physiology. As an addition, the lining of the small intestines have intervening simple tubular glands. The main absorptive and secretive cell types found in these glands are **goblet cells** and **enterocytes**. **Paneth cells** produce defensins that are needed as a first-line defense against invading pathogens. **Neuroendocrine cells** that produce different hormones upon stimulation can also be found in the intestines.

Approach to Patients with Malabsorption Problems

The diagnosis of malabsorption among patients depends largely on the history, signs and symptoms, and the physical examination. Performing an inquiry to these things at the start may help in limiting the use of redundant laboratory exams and imaging techniques, although these may help in strengthening the diagnosis.

The **absorptive capacity** of the small intestine somewhat varies depending on which part of the intestines we are talking about. For instance, certain nutrients, vitamins, and minerals may be absorbed in one location and may be retained in the lumen in another. This fact can help in delineating which part of the small intestines are affected. For instance, a condition where steatorrhea and vitamin B12 deficiency could indicate problems in the ileal portion of the intestines.

Once the **history and physical examination** is over and done, **laboratory tests** can now be performed to the patient in order to further strengthen the diagnosis and rule out any impressions that might not be relevant to the case. In cases of malabsorption, certain

laboratory tests can be ordered to achieve this, such as:

Schilling test

This test **measures the integrity of the absorptive capacity of the intestinal mucosa by observing the presence of cobalamin in the urine** as a measurement of its absorption in the bloodstream. This dietary element undergoes some processes before it eventually gets absorbed in the intestinal epithelial cells.

Since cobalamin is bound to meet and remains unusable as is, proteases from the pancreas mobilize the element. The unbound cobalamin is then absorbed in the ileal mucosa with the aid of an **intrinsic factor** that is produced in the parietal cells in the stomach. Conditions that could indicate an abnormal Schilling test results include pernicious anemia, chronic pancreatitis, achlorhydria, ileal dysfunction, and of course, bacterial overgrowth syndromes.

	Cobalamin	With intrinsic factor	With pancreatic enzymes	After 5 days of antibiotics
Pernicious anemia	Reduced	Normal	Reduced	Reduced
Chronic pancreatitis	Reduced	Reduced	Normal	Reduced
Bacterial overgrowth	Reduced	Reduced	Reduced	Normal
Ileal disease	Reduced	Reduced	Reduced	Reduced

(Table adapted from Harrison's Gastroenterology and Hepatology by Longo DL and Fauci AS)

Urinary D-xylose test

Just like select nutrients, the pentose D-xylose is said to be absorbed only in the proximal portion of the small intestines. Its **presence in the urine means that the proximal portion of the small intestines is intact**. The high probability of false-negative results has caused its unpopular use in the clinical setting nowadays.

Radiographic imaging

The most commonly used radiologic technique to visualize the integrity of the small intestines is **barium instillation**. This technique provides a sufficient visualization of the intestinal mucosa, particularly that of the ileum. This imaging process is commonly done along with contrast imaging with the [esophagus](#), stomach, and the large intestines. This is very helpful in detecting structural problems such as strictures, fistulas, and outpouchings. Other popular visualization techniques include endoscopy and double-barreled enteroscopy.

Biopsy of the intestinal mucosa

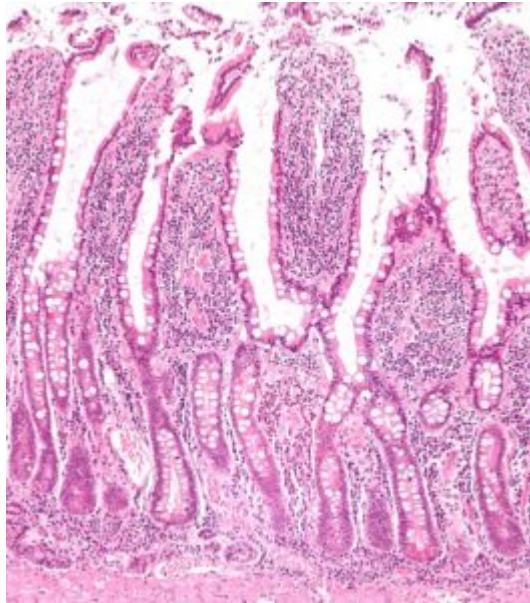


Image: "Low magnification micrograph of small intestinal mucosa. H&E stain." by Nephron. License: [CC BY-SA 3.0](https://creativecommons.org/licenses/by-sa/3.0/)

The relative ease and conclusive results obtained by this technique have somewhat reduced the use of urinary D-xylose test. Although very helpful, this test is not as commonly done as other diagnostic techniques because of the presence of more convenient methods such as endoscopy which provides direct visualization as well.

Also, only a few nutrient malabsorption conditions also manifest with histologic aberrations. The types of lesions that can serve as the focal point for biopsy are diffuse, specific lesions; patchy specific lesions; lesions caused by microorganisms; and diffuse, general lesions.

Small Intestinal Bacterial Overgrowth

Normally, the gut is a residence for a fair amount of microorganisms that can either improve the conditions in the intestinal lumen or maintain being neutral and non-invasive. This **symbiotic relationship between bacteria and the small intestine** has been said to be around since the time we are born and continue to exist as long as normal conditions are maintained. The most commonly found bacteria in the small intestines and the rest of the digestive tract are the following:

- Lactobacilli
- Enterococci
- Gram (+) aerobes and facultative anaerobes
- Streptococci

In the presence of disruptions in the normal environment in the small intestine, these microorganisms along with other bacteria and fungi can proliferate and cause disease. This is called the **small intestine bacterial overgrowth** or **SIBO**. It can also be called **stagnant bowel syndrome** or **blind loop syndrome**.

SIBO tends to be underdiagnosed due to the fact that the signs and symptoms are not far from different from other gastrointestinal disorders. This fact amplifies the need to perform a thorough health history and physical examination. The manifestations and the degree of morbidity vary among different populations. The conditions that would most likely place a person at risk to suffer SIBO are:

- Extremes of age
- Malnourishment
- Inborn structural and functional defects
- History of surgery or intake of certain medications
- Concurrent disorders such as [diabetes mellitus](#)

Pathogenesis of SIBO

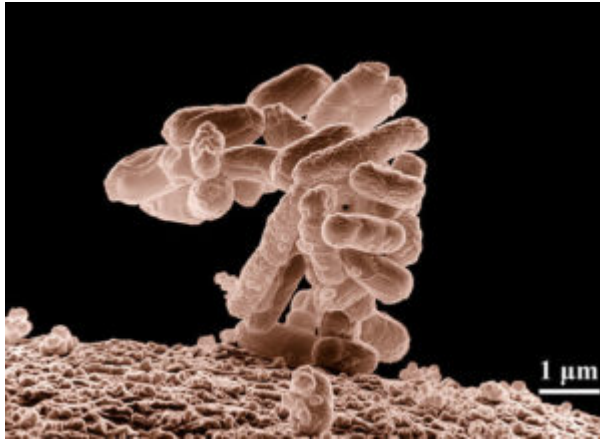


Image: "Low-temperature electron micrograph of a cluster of E. coli bacteria, magnified 10,000 times. Each individual bacterium is oblong shaped." by Photo by Eric Erbe, digital colorization by Christopher Pooley, both of USDA, ARS, EMU.. License: Public Domain

The primary known reason for bacterial overgrowth in the small intestine is the **stasis of the bowel contents**. This happens as the immobilized bacteria, particularly anaerobes dominate and proliferate in the lumen. These microorganisms resemble that of the normal flora of the colon, the most common among which is E. coli and Bacteroides. This commonly occurs in chronic conditions such as diabetes mellitus, [Crohn's disease](#), and scleroderma.

It can also occur with **secondary structural obstructions** caused by gastrointestinal surgeries such as gastrointestinal anastomoses. It could even be caused by conditions following other iatrogenic procedures such as radiotherapy. In conditions with significant gastrointestinal manifestations such as [AIDS](#), the associated [diarrhea](#) is said to be caused by the overgrowth of bacteria.

The manifestations of SIBO can be explained by the malabsorptive conditions brought about by the bacterial overgrowth.

The anemia present in SIBO can be explained by the impaired absorption of cobalamin in the intestines. Aside from the damage in the mucosa of the ileum bringing about poor absorption, the present bacteria also compete with the host for cobalamin. Since the overgrowing bacteria has the ability to deconjugate bile acids, poor fat emulsification and digestion can follow. Steatorrhea will be the result. Diarrhea can be caused by the many pathological changes in the intestines and with the enterotoxins produced by the organisms.

Inflammation due to bacterial overgrowth may interfere with the production and secretion of mucus. Recently, this effect has linked SIBO to conditions like cystic fibrosis, irritable bowel syndrome and chronic abdominal pain.

SIBO is found in up to 70% of chronic liver disease patients and has been linked to the progression of CLD and cirrhosis.

SIBO is also found in up to one-third of patients with chronic pancreatitis and its treatment may improve the clinical status in such patients.

Pathology of SIBO

Not all cases of SIBO necessarily have significant pathological changes in the intestinal villi. Rarely does it happen when flat lesions are present? One can distinguish this lesion from that of celiac sprue by observing varying degrees of involvement in biopsy specimens taken from the same lesion. Intraepithelial lymphocytes and occasional neutrophils can be found as well.

Diagnosis of SIBO

Aside from the **frank proliferation of colonic bacteria in the small intestine**, other systemic manifestations can be a trigger for more in-depth probing of the cause of the signs and symptoms. For one, **cobalamin deficiency** that is partnered with a high blood level of folate is highly indicative of SIBO. This is because aside from the poor absorption of cobalamin in the ileum, the bacteria in stasis tend to produce significant amounts of folate that is absorbed in the duodenum. Other tests such as Schilling test can also be used to rule out other causes of malabsorption.

Culture of intestinal aspirates is the gold standard for SIBO diagnosis. Growth of bacteria more than 10^5 colony forming unit (CFU) per milliliter is diagnostic of SIBO.

The newer diagnostic procedures used to diagnose SIBO include breath tests for various substances such as hydrogen, glucose, lactulose, methane, ^{13}C mixed triglyceride.

Due to non-availability of these specialized tests, the diagnosis is commonly suspected clinically and confirmed by the response to treatment.

Treatment of SIBO

The secondary nature of SIBO dictates that in order to completely address the overgrowth of bacteria, the **primary cause of stasis should be removed**. Patency throughout the small intestinal lumen should be maintained surgically or functionally.

Antibiotic treatment is usually started to control the bacterial population. Antibacterials such as metronidazole, amoxicillin/clavulanic acid, rifaximin and cephalosporins usually offer sufficient coverage for the common bacterial causatives for SIBO. These drugs are given at a minimum of 3 weeks or until manifestations abate. Other health care providers also make use of the 1-week per month antibiotic regimen and have reported positive results.

Probiotic supplementation is being experimented to treat SIBO.

Therapy is usually empirical, with little evidence available to guide clinical decision making about the antibiotic choice, treatment duration, and therapy for recurrences.

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