What is the appendix?
The appendix is a closed-ended, narrow tube that attaches to the cecum (the first part of the colon) like a worm. (The anatomical name for the appendix, vermiform appendix, means worm-like appendage.) The inner lining of the appendix produces a small amount of mucus that flows through the appendix and into the cecum. The wall of the appendix contains lymphatic tissue that is part of the immune system for making antibodies. Like the rest of the colon, the wall of the appendix also contains a layer of muscle.

What is appendicitis?
Appendicitis is inflammation of the appendix. It is thought that appendicitis begins when the opening from the appendix into the cecum becomes blocked. The blockage may be due to a build-up of thick mucus within the appendix or to stool that enters the appendix from the cecum. The mucus or stool hardens, becomes rock-like, and blocks the opening. This rock is called a fecolith (literally, a rock of stool). At other times, the lymphatic tissue in the appendix may swell and block the appendix. Bacteria which normally are found within the appendix then begin to invade (infect) the wall of the appendix. The body responds to the invasion by mounting an attack on the bacteria, an attack called inflammation. (An alternative theory for the cause of appendicitis is an initial rupture of the appendix followed by spread of bacteria outside the appendix. The cause of such a rupture is unclear, but it may relate to changes that occur in the lymphatic tissue that line the wall of the appendix.)

If the inflammation and infection spread through the wall of the appendix, the appendix can rupture. After rupture, infection can spread throughout the abdomen; however, it usually is confined to a small area surrounding the appendix (forming a peri-appendiceal abscess).

Sometimes, the body is successful in containing ("healing") the appendicitis without surgical treatment if the infection and accompanying inflammation do not spread throughout the abdomen. The inflammation, pain and symptoms may disappear. This is particularly true in elderly patients and when antibiotics are used. The patients then may come to the doctor long after the episode of appendicitis with a lump or a mass in the right lower abdomen that is due to the scarring that occurs during healing. This lump might raise the suspicion of cancer.

What are the complications of appendicitis?
The most frequent complication of appendicitis is perforation. Perforation of the appendix can lead to a periappendiceal abscess (a collection of infected pus) or diffuse peritonitis (infection of the entire lining of the abdomen and the pelvis). The major reason for appendiceal perforation is delay in diagnosis and treatment.

A less common complication of appendicitis is blockage of the intestine. Blockage occurs when the inflammation surrounding the appendix causes the intestinal muscle to stop working, and this prevents the intestinal contents from passing. If the intestine above the blockage begins to fill with liquid and gas, the abdomen distends and nausea and vomiting may occur. It then may be necessary to drain the contents of the intestine through a tube passed through the nose and esophagus and into the stomach and intestine.

A feared complication of appendicitis is sepsis, a condition in which infecting bacteria enter the
blood and travel to other parts of the body. This is a very serious, even life-threatening complication. Fortunately, it occurs infrequently.

What are the symptoms of appendicitis?
The main symptom of appendicitis is abdominal pain. The pain is at first diffuse and poorly localized, that is, not confined to one spot. (Poorly localized pain is typical whenever a problem is confined to the small intestine or colon, including the appendix.) The pain is so difficult to pinpoint that when asked to point to the area of the pain, most people indicate the location of the pain with a circular motion of their hand around the central part of their abdomen.

As appendiceal inflammation increases, it extends through the appendix to its outer covering and then to the lining of the abdomen, a thin membrane called the peritoneum. Once the peritoneum becomes inflamed, the pain changes and then can be localized clearly to one small area. Generally, this area is between the front of the right hip bone and the belly button. The exact point is named after Dr. Charles McBurney--McBurney's point. If the appendix ruptures and infection spreads throughout the abdomen, the pain becomes diffuse again as the entire lining of the abdomen becomes inflamed.

Nausea and vomiting also occur in appendicitis and may be due to intestinal obstruction.

How is appendicitis diagnosed?
The diagnosis begins with a thorough history and physical examination. Patients often have an elevated temperature, and there usually will be moderate to severe tenderness in the right lower abdomen when the doctor pushes there. If inflammation has spread to the peritoneum, there is frequently rebound tenderness. This means that when the doctor pushes on the abdomen and then quickly releases his hand, the pain becomes suddenly but transiently worse.

White Blood Cell Count
The white blood cell count in the blood usually becomes elevated with infection. In early appendicitis, before infection sets in, it can be normal, but most often there is at least a mild elevation even early. Unfortunately, appendicitis is not the only condition that causes elevated white blood cell counts. Almost any infection or inflammation can cause this count to be abnormally high. Therefore, an elevated white blood cell count alone cannot be used as a sign of appendicitis.

Urinalysis
Urinalysis is a microscopic examination of the urine that detects red blood cells, white blood cells and bacteria in the urine. Urinalysis usually is abnormal when there is inflammation or stones in the kidneys or bladder which sometimes can be confused with appendicitis. Therefore, an abnormal urinalysis suggests that there is a kidney or bladder problem while a normal urinalysis is more characteristic of appendicitis.

Abdominal X-Ray
An abdominal x-ray may detect the fecalith (the hardened and calcified, pea-sized piece of stool that blocks the appendiceal opening) that may be the cause of appendicitis. This is especially true in children.
**Ultrasound**

An ultrasound is a painless procedure that uses sound waves to identify organs within the body. Ultrasound can identify an enlarged appendix or an abscess. Nevertheless, during appendicitis, the appendix can be seen in only 50% of patients. Therefore, not seeing the appendix during an ultrasound does not exclude appendicitis. Ultrasound also is helpful in women because it can exclude the presence of conditions involving the ovaries, fallopian tubes and uterus that can mimic appendicitis.

**Barium Enema**

A barium enema is an x-ray test where liquid barium is inserted into the colon from the anus to fill the colon. This test can, at times, show an impression on the colon in the area of the appendix where the inflammation from the adjacent inflammation impinges on the colon. Barium enema also can exclude other intestinal problems that mimic appendicitis, for example Crohn's disease.

**CT Scan**

In patients who are not pregnant, a CT Scan of the area of the appendix is useful in diagnosing appendicitis and peri-appendiceal abscesses as well as in excluding other diseases inside the abdomen and pelvis that can mimic appendicitis.

**Laparoscopy**

Laparoscopy is a surgical procedure wherein a small fiberoptic tube with a camera is inserted into the abdomen through a small puncture made on the abdominal wall. Laparoscopy allows a direct view of the appendix as well as other abdominal and pelvic organs. If appendicitis is found, the inflamed appendix can be removed at the same time. The disadvantage of laparoscopy compared to ultrasound and CT scanning is that it requires a general anesthetic.

There is no one test that will diagnose appendicitis with certainty. Therefore, the approach to suspected appendicitis may include a period of observation, tests as previously discussed, or surgery.

**Why can it be difficult to diagnose appendicitis?**

It can be difficult to diagnose appendicitis. The position of the appendix in the abdomen may vary. Most of the time the appendix is in the right lower abdomen, but the appendix, like other parts of the intestine, has a mesentery. This mesentery is a sheet-like membrane that attaches the appendix to other structures within the abdomen. If the mesentery is large, it allows the appendix to move around. In addition, the appendix may be longer than normal. The combination of a large mesentery and a long appendix allows the appendix to dip down into the pelvis (among the pelvic organs in women). It also may allow the appendix to move behind the colon (called a retro-colic appendix). In either case, inflammation of the appendix may act more like the inflammation of other organs, for example, a woman's pelvic organs.

The diagnosis of appendicitis also can be difficult because other inflammatory problems may mimic appendicitis. Therefore, it is common to observe patients with suspected appendicitis for a period of time to see if the problem will resolve on its own or develop characteristics that more strongly suggest appendicitis or, perhaps, another condition.
What other conditions can mimic appendicitis?

The surgeon faced with a patient suspected of having appendicitis always must consider and look for other conditions that can mimic appendicitis. Among the conditions that mimic appendicitis are:

* Meckel's diverticulitis.
  A Meckel's diverticulum is a small outpouching of the small intestine which usually is located in the right lower abdomen near the appendix. The diverticulum may become inflamed or even perforate (break open or rupture). If inflamed and/or perforated, it usually is removed surgically.

* Pelvic inflammatory disease. The right fallopian tube and ovary lie near the appendix. Sexually active women may contract infectious diseases that involve the tube and ovary. Usually, antibiotic therapy is sufficient treatment, and surgical removal of the tube and ovary are not necessary.

* Inflammatory diseases of the right upper abdomen. Fluids from the right upper abdomen may drain into the lower abdomen where they stimulate inflammation and mimic appendicitis. Such fluids may come from a perforated duodenal ulcer, gallbladder disease, or inflammatory diseases of the liver, e.g., a liver abscess.

* Right-sided diverticulitis. Although most diverticuli are located on the left side of the colon, they occasionally occur on the right side. When a right-sided diverticulum ruptures it can provoke inflammation they mimics appendicitis.

* Kidney diseases. The right kidney is close enough to the appendix that inflammatory problems in the kidney—for example, an abscess—can mimic appendicitis.

How is appendicitis treated?

Once a diagnosis of appendicitis is made, an appendectomy usually is performed. Antibiotics almost always are begun prior to surgery and as soon as appendicitis is suspected.

There is a small group of patients in whom the inflammation and infection of appendicitis remain mild and localized to a small area. The body is able not only to contain the inflammation and infection but to resolve it as well. These patients usually are not very ill and improve during several days of observation. This type of appendicitis is called "confined appendicitis" and may be treated with antibiotics alone. The appendix may or may not be removed at a later time.

On occasion, a person may not see their doctor until appendicitis with rupture has been present for many days or even weeks. In this situation, an abscess usually has formed, and the appendiceal perforation may have closed over. If the abscess is small, it initially can be treated with antibiotics; however, the abscess usually requires drainage. A drain usually is inserted with the aid of an ultrasound or CT scan that can determine the exact location of the abscess. The appendix is removed several weeks or months after the abscess has resolved. This is called an interval appendectomy and is done to prevent a second attack of appendicitis.

How is an appendectomy done?

During an appendectomy, an incision two to three inches in length is made through the skin and the layers of the abdominal wall in the area of the appendix. The surgeon enters the abdomen and looks for the appendix, usually located in the right lower abdomen. After examining the area around the appendix to be certain that no additional problem is present, the appendix is removed. This is done by freeing the appendix from its attachment to the abdomen.
and to the colon, cutting the appendix from the colon and sewing over the hole in the colon. If an abscess is present, the pus can be drained with drains (rubber tubes) that go from the abscess and out through the skin. The abdominal incision then is closed.

Newer techniques for removing the appendix involve the use of the laparoscope. The laparoscope is a thin telescope attached to a video camera that allows the surgeon to inspect the inside of the abdomen through a small puncture wound (instead of a larger incision). If appendicitis is found, the appendix can be removed with special instruments that can be passed into the abdomen, just like the laparoscope, through small puncture wounds. The benefits of the laparoscopic technique include less post-operative pain (since much of the post-surgery pain comes from incisions) and a speedier recovery. An additional advantage of laparoscopy is that it allows the surgeon to look inside the abdomen to make a clear diagnosis in cases in which the diagnosis of appendicitis is in doubt. For example, laparoscopy is especially helpful in menstruating women in whom a rupture of an ovarian cysts may mimic appendicitis.

If the appendix is not ruptured (perforated) at the time of surgery, the patient generally is sent home from the hospital in one or two days. Patients whose appendix has perforated generally are sicker than patients without perforation. After surgery, their hospital stay often is prolonged (four to seven days), particularly if peritonitis has occurred. Intravenous antibiotics are given in the hospital to fight infection and assist in resolving any abscess.

Occasionally, the surgeon may find a normal-appearing appendix and no other cause for the patient's problem. In this situation, the surgeon may remove the appendix. The reasoning in these cases is that it is better to remove a normal-appearing appendix than to miss and not treat appropriately an early or mild case of appendicitis.

What are the complications of appendectomy?

The most common complication of appendectomy is infection of the wound, that is, of the surgical incision. Such infections vary in severity from mild, with only redness and perhaps some tenderness over the incision, to moderate, requiring only antibiotics, to severe, requiring antibiotics and surgical treatment. Occasionally, the inflammation and infection of appendicitis are so severe that the surgeon will not close the incision at the end of the surgery because of concern that the wound is already infected. Instead, the surgical closing is postponed for several days to allow the infection to subside with antibiotic therapy and make it less likely for infection to occur within the incision.

Another complication of appendectomy is an abscess, a collection of pus in the area of the appendix. Although abscesses can be drained of their pus surgically, there are also non-surgical techniques, as previously discussed.

Are there long-term consequences of appendectomy?

It is not clear if the appendix has an important role in the body in older children and adults. There are no major, long-term health problems resulting from removing the appendix although a slight increase in some diseases has been noted, for example, Crohn's disease.

Appendectomy At A Glance
Appendectomy

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*The appendix is a small, worm-like appendage attached to the colon. *Appendicitis occurs when bacteria invade and infect the wall of the appendix. *The most common complications of appendicitis are abscess and peritonitis. *The most common manifestations of appendicitis are pain, fever, and abdominal tenderness. *Appendicitis usually is suspected on the basis of a patient's history and physical examination; however, a white blood cell count, urinalysis, abdominal x-ray, barium enema, ultrasonography, CT, and laparoscopy also may be helpful in diagnosis.