Lectures of Basic Human Anatomy

Functional Anatomy of Small Intestine

By

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Abdominal Regions

![Diagram showing the 9 Abdominal Regions](image_url)

Small Intestine

- It is the longest part of the alimentary tract.
- It extends from the pylorus of stomach to the ileo-coecal junction.

**Divisions:** It is divided for description into 3 parts, as follows:
1. Duodenum,
2. Jejunum,
3. Ileum.

Duodenum

- It is the most fixed part of small intestine, having no mesentery, except the 1\textsuperscript{st} one inch called **duodenal cap**.
- **Site:** It lies on the posterior abdominal wall, being situated in the epigastric and umbilical regions.
- **Length:** 10 inches (25cm) in length.
- **Shape:** It is a C-shaped tube, surrounding the head of pancreas.
- **Duodenal cap:** It is the 1\textsuperscript{st} one inch of duodenum. It resembles the stomach in having attachment to the lesser omentum and greater omentum. It is relatively dilated and smooth-walled. It is the most common site of duodenal ulcer. This is because: it is the first site of meeting of the acidic gastric secretion with
Duodenal mucosa before mixing with the alkaline duodenal secretion.

Duodenal cap X-ray

Parts of Duodenum & Surface Anatomy:

- **1st part**: is 2 inch in length. It runs horizontally at the level of LI vertebra "trans-pyloric plane", starting half an inch to the right of the median plane. It begins at the pylorus of stomach, about half an inch to the right of median plane.
- **2nd part**: 3 inches long. It runs vertically from the level of L1 to L3 vertebra.
- **3rd part**: is 4 inches long. It runs horizontally at the level of L3 vertebra "sub-costal plane".
- **4th part**: is one inch long. It ascends from level of L3 to L2 vertebra to end at the duodeno-jejunal flexure about 1 inch to the left of median plane. Here, a well-defined fold of peritoneum called "ligament of Treitz". ascends to join the right crus of diaphragm and holds this junction in position.
Relations of Duodenum:

<table>
<thead>
<tr>
<th>Part</th>
<th>Anterior</th>
<th>Posterior</th>
<th>Superior</th>
<th>Inferior</th>
<th>Medial</th>
<th>Lateral</th>
</tr>
</thead>
<tbody>
<tr>
<td>1&lt;sup&gt;st&lt;/sup&gt; part</td>
<td>Gall bladder, quadrate lobe of liver</td>
<td>Lesser sac (first one inch)</td>
<td>Entrance to lesser sac</td>
<td>Head of pancreas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4&lt;sup&gt;th&lt;/sup&gt; part</td>
<td>* Beginning of root of mesentery, * Coils of small intestine.</td>
<td>* Left psoas Major, * Left margin of aorta</td>
<td></td>
<td>* Head of pancreas</td>
<td>* Body of pancreas</td>
<td></td>
</tr>
</tbody>
</table>
**Mucous Membrane**
Except the 1st one inch which is smooth, the mucous membrane of duodenum shows circular folds, called *plicae circulares*. The bile duct and main pancreatic duct unite together and form a dilatation in the wall of the 2nd part of duodenum, just below its middle, called *Ampulla of Vater*, that forms an elevation called **major duodenal papilla**. At the summit of this papilla, the duct opens into duodenum. This opening is guarded by the *sphincter of Oddi*. Another papilla may be present about 2 cm above the major papilla, called **minor duodenal papilla**, at which the accessory pancreatic duct, if present, opens into the duodenum.

![](image)

*Entrance of Bile and Main Pancreatic duct into Duodenum*

**Blood supply of Duodenum**

**Arterial Supply:**
Duodenum is supplied by 2 sources of blood vessels. The basis of this transition is embryological because it is the site of the junction of the foregut and midgut.

1. **Superior pancreatico-duodenal artery**: supplying the upper half of duodenum, "derived from the foregut". This artery is a branch of gastroduodenal artery that arises from the *coeliac trunk* (artery of foregut).

2. **Inferior pancreatico-duodenal artery**: supplying the lower half of duodenum, "derived from the midgut". This artery is a branch of *superior mesenteric artery* (artery of midgut).
Venous Drainage:
The corresponding veins drain into the portal circulation.
- **Superior pancreatico-duodenal** vein drains directly into the portal vein.
- **Inferior pancreatico-duodenal** vein drains into the portal vein through joining the superior mesenteric vein.

Lymph Drainage:
The lymphatic vessels follow the arteries to end in coeliac lymph nodes around the celiac trunk and superior mesenteric lymph nodes around superior mesenteric artery.

Nerve supply:
It is autonomic nerve supply; sympathetic (from the coeliac and superior mesenteric plexuses) and parasympathetic (vagus) nerves.

**Coils of Small Intestine (Jejunum & Ileum)**
They represent the free part of the small intestine, of about 6m in length.

The jejunum represents the upper 2/5ths, while ileum represents the lower 3/5ths of coils of small intestine. There is no sharp distinction between jejunum and ileum. However, there are certain characteristics distinguishing between them.
The differences between jejunum and ileum include:

<table>
<thead>
<tr>
<th></th>
<th>Jejunum</th>
<th>Ileum</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Length</strong></td>
<td>Proximal 2/5ths of free part of small intestine.</td>
<td>Distal 3/5ths of free part of small intestine.</td>
</tr>
<tr>
<td><strong>Site</strong></td>
<td>Upper part &quot;umbilical region&quot;.</td>
<td>Lower abdomen and pelvis.</td>
</tr>
<tr>
<td><strong>Mucosal circular folds</strong></td>
<td>More prominent</td>
<td>Less prominent.</td>
</tr>
<tr>
<td><strong>Villi</strong></td>
<td>Larger</td>
<td>Smaller</td>
</tr>
<tr>
<td><strong>Diameter</strong></td>
<td>Greater</td>
<td>Lesser</td>
</tr>
<tr>
<td><strong>Thickness</strong></td>
<td>Greater</td>
<td>Greater</td>
</tr>
<tr>
<td><strong>Lymphoid follicles</strong></td>
<td>No</td>
<td>Many, May form aggregations (Peyer's patches)</td>
</tr>
<tr>
<td><strong>Mesentery</strong></td>
<td>- With a small amount of fat (windows)</td>
<td>With a great amount of fat (no windows)</td>
</tr>
<tr>
<td><strong>Arterial arcades</strong></td>
<td>Simple system (one or 2 arcades)</td>
<td>Complicated system (3 or more arcades)</td>
</tr>
</tbody>
</table>

The free part of small intestine is connected to the posterior abdominal wall by a fold of peritoneum, called **mesentery**.

*(Mesentery, mes=middle & enter= intestine)*

**Mesentery**
It is a fold of peritoneum, enclosing the free part of small intestine.

**Shape**: It is a fan-shaped; having: 2 borders and 2 layers.

**Borders**: (2)

1. Free border: containing the jejunum and ileum, so its length is about 6 meters.
2. Attached border (or root): is attached to the posterior abdominal wall. Its length is about 6 inches.
   * The root follows a curved course (concavity towards the right), extending from the duodeno-jejunal flexure to the ileocecal junction.

**Layers**: (2) right and left layers. They are continuous at the root of the mesentery with peritoneum of the posterior abdominal wall.

**Contents of mesentery**:

3. Jejunal and ileal branches of superior mesenteric artery and the accompanying veins. These arteries anastomose together, forming arterial arcades, from which small straight branches pass to supply the intestine.
4. Dense plexus of sympathetic fibers accompany the branches of the superior mesenteric artery.
5. Mesenteric lymph nodes.
6. Mesenteric fatty tissue (extra-peritoneal fatty tissue).

*Mesentery of small intestine*  
*Contents of mesentery of small intestine*

*Sagittal Section in Female Abdomen and Pelvis to show Peritoneum*
**Clinical Applications:**
Peptic ulcers mostly occur in the stomach and duodenum (duodenal cap). It is caused via imbalance between the acid secretion and mucosal protection of stomach. Also, *Helicobacter pylori* infection is an etiological factor so that for treatment of peptic ulcers, it must control this infection as well as treatment of hyperacidity. Sometimes, *vagotomy* may be needed if medical treatment is not effective.

Length of small intestine is so long as resection of a third or even half of the small intestine is compatible with normal life.

**Microscopic Anatomy**

**General Structure of GIT:**
The general structure of the alimentary canal follows a similar pattern from the level of the esophagus onwards.
The wall of the alimentary canal is formed of 4 layers of tissue as follows:

1. **Mucosa:** It is the inner lining. It secretes mucous to lubricate the walls and protect them from the digestive enzymes.
2. **Submucosa:** It is the areolar tissue, lying between the mucosa and the muscle layer. It contains the larger blood vessels, nerves and mucous glands.
3. **Muscular layer:** Its muscle fibers are arranged in 2 layers; inner circular and outer longitudinal.
4. **Adventitia (outer covering):** In the thorax, it consists of loose fibrous tissue, but in the abdomen it is covered by the peritoneum.
Structures increasing the surface area of the small intestine, in addition to plicae circularis include:

- **Microvilli.** Increase surface area of absorptive cells and, collectively, form a brush or striated border
- **Villi.** Finger-like protrusions of the lamina propria and overlying epithelium into the lumen. Villi assume different shapes in each of the three intestinal subdivisions.

N.B.: In the duodenum they are leaf-shaped, but gradually assume fingerlike shapes moving toward the ileum. Villi are covered by a simple columnar epithelium of **absorptive cells** and **goblet cells** (mucous-secreting cells).

Also, **Brunner’s glands** in the submucosa are present only in the duodenum. These compound tubular glands open into the bases of the intestinal glands and secrete an alkaline mucus to neutralize the acidity of the stomach contents.

- **Peyer’s patches** are aggregations of 10–200 lymphoid nodules located primarily in the lamina propria of the ileum. They are
positioned on the side of the intestine away from the mesentery and form bulges that may protrude into the lumen as well as into the submucosa.