Gastrointestinal Tract

The gastrointestinal tract (GI tract or gut) extends from the mouth to the cloaca (Fig. 164). It is demarked by structural and functional divisions. The mouth captures and processes food. The esophagus conveys food to the stomach and expels excess water. It also works with the tongue in swallowing. The stomach starts the chemical and physical process of digestion. In the small intestines, digestive enzymes are added to food to break down proteins and complex carbohydrates. The small intestines are regionally specialized to absorb amino acids, carbohydrates, sugars, water, fatty acids, and minerals (particularly calcium and phosphorus). The large intestine (colon) typically reclaims water. The length of the gut is somewhat related to diet. It is proportionally longer in green and leatherback turtles than in loggerheads, ridleys, and hawksbills.

Figs. 164a and 164b. The gastrointestinal tract with digestive glands and the spleen. The GI tract from the esophagus to the rectum from a Kemp’s ridley turtle shows the different regions as well as the associated digestive glands, the liver and pancreas. The gall bladder stores bile, produced by the liver, and releases it through the common bile duct when food enters the duodenum. The spleen, located at the distal end of the pancreas, is not a digestive gland; rather it is a lymphoid organ in turtles involved in immunological activity.
GASTROINTESTINAL ANATOMY

The mouth includes several GI, respiratory, and ear structures: the mandibles and the pharynx includes the palate, esophagus, glottis, Eustachian tubes, and internal choanae (Fig. 165). For convenience, these structures will be described together here. The glottis and internal choanae are part of the respiratory system and the Eustation tube connects the pharynx with the middle ear cavity. The tongue is fixed to the floor of the mouth and is not protrusable. The glottis is located on the middle part of the tongue (see Sense Organs, Fig. 209), just posterior and ventral to the internal choanae (internal nares); it acts as a valve to open and close the airway. The esophagus starts at the back of the tongue; it is a muscular tube that leads to the stomach. It passes slightly dorsal and to the right of the trachea. The Eustachian tubes (one on each side), are found in the posterolateral aspects of the mouth, medial to the jaw joint; they function in maintaining normal pressure in the middle ear (Fig. 165).

Figs. 165a and 165b. Ventral view of the palate with the tongue and hyoid apparatus cut away. The roof of the mouth has internal choanae (internal nares) that open above the glottis (removed in this picture). In the posterior lateral parts of the palate, near the jaw joint, are the openings to the Eustachian tubes, which lead to the middle ear cavity.
The esophagus (Fig. 166) is lined with **papillae** that are sharp and keratinized; they point inward towards the stomach. The papillae end where the esophagus joins the stomach (Fig. 166). The papillae are presumed to trap food while excess water is expelled prior to swallowing. In Atlantic green turtles, the esophagus enters the stomach in a smooth transition. However, in Pacific green turtles, there is a muscular specialization at the base of the esophagus called a **crop**. Its function is unclear. In cheloniids, the esophagus descends to a position just inside the plastron and bends to the left in an S-shaped curve to join the stomach. In *Dermochelys*, the esophagus is exceptionally long and extends almost half the length of the body before looping to the left, and returning anteriorly almost to the level of the axilla. There, the esophagus bends left again and joins the stomach (Fig. 167).

**Figs. 166a and 166b.** The esophagus and anterior stomach lining. The papillae that line the esophagus are keratinized for most of the length of the esophagus. They end abruptly; several flat, transitional papillae, lacking keratin line the esophageal wall at the level of the gastroesophageal sphincter. Posterior to this sphincter, the stomach lining is very smooth and has no papillae.
Figs. 167a and 167b. Ventral view of a leatherback hatchling’s viscera and heart. This dissection of a leatherback posthatchling shows the extremely long esophagus, large stomach, and small intestines. On the animal's right is the remaining yolk sac. The yolk sac can persist well after the time that the animal has begun feeding.

In this animal, the coracoid processes were cut away and the acromion processes reflected anteriorly to provide a clear view of the heart and liver. The ventricle is pushed anteriorly exposing the sinus venosus, which was injected with latex to provide contrast.

The stomach is on the animals left side and curves around the more medially located liver and pericardium. It is attached to the liver's left lobe by a gastrohepatic ligament and the left lung by a gastropulmonary ligament. The stomach is smooth-walled along its length. It ends in a short muscular region, the pylorus (= pyloric sphincter or valve). The pylorus is usually constricted and the intestinal lining on the duodenal side of the sphincter differs from that of the stomach (Fig. 169).

The pancreas runs distally along the duodenum from the pylorus to just past the common bile duct (Fig. 170). Both the pancreas and the common bile duct (from the gall bladder) deliver digestive enzymes to the duodenum. The common bile duct enters the duodenum via a small papilla, the ampulla of Vater, on the duodenum’s internal surface. Its location can be identified from the green bile stain (Figs. 170-171). The pancreatic duct (not shown) is difficult to locate in all but the largest turtles; it enters the duodenum near or in
common with the common bile duct. The duodenum's lining is textured and, in some species, it is "honey-combed" in appearance (Fig. 171). This textured lining is associated with increased surface area and is well-developed in green turtles and leatherbacks. It is not as pronounced in the carnivorous/omnivorous species (e.g., loggerheads, ridleys, and hawksbills).

The transitions from one type of small intestine to the next (duodenum to jejunum to ileum) are often difficult to identify. Gross differences are often not obvious and are best confirmed by histological examination for the functional characteristics of the tissues. The transition from ileum to colon is clear. The ileum ends in a muscular sphincter, the iliocaecal valve. The proximal end of the colon is a caecum (pouch) that bulges somewhat more than the remaining large intestine (Fig. 77). It is more prominent in green turtles than other species. The colon narrows somewhat past the caecum; it is constricted weakly by segmentally arranged bands of muscle. Distally, the colon tapers to form a muscular rectum, which is often pigmented; its muscular walls are thickened and folded (Fig. 172).

Figs. 169a and 169b. Linings of the stomach and duodenum. The stomach and duodenum are separated by a short muscular sphincter, the pylorus. While stomach lining is generally smooth, that of the duodenum is often textured. In the leatherback and green turtle, there are the overlapping crypts containing mucus found along the length of the duodenum and into the jejunum.
**Fig. 170.** Longitudinal section of the duodenum. The common bile duct opens into the duodenum at a papilla (termed the Ampulla of Vater). The common bile duct extends from the gallbladder to the duodenum.

**Fig. 171.** Longitudinal section through the liver and gallbladder. The walls of the gallbladder are removed dorsally to expose the common bile duct to the duodenum.
The rectum empties into the cloaca (Fig. 171), a chamber that also receives the urine from the kidneys, eggs or sperm, and connects ventrally into the urinary bladder. The cloaca empties to the outside via the cloacal opening or vent. Each function of the cloaca is associated with a region into which the products empty. The **coprodeum** received feces from the rectum. The **urodeum** is associated with the **urinary papillae** and the opening of the urinary bladder. The **proctodeum** is the most distal region and is associated functionally with copulation and structurally with proximity to the genital ducts.