DESK REFERENCE

A Histological Atlas of Florida Surgeonfish
(Acanthuridae)

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TP123

Introduction

Acanthurids are an important group of reef fishes, because of their impact as herbivores on reef ecology (Carpenter 1986), and their popularity as display animals. The acanthurids are extremely abundant in tropical and subtropical waters. Three species are found in the waters of the Florida Keys: *Acanthurus coeruleus* (blue tang), *A. bahianus* (ocean surgeon), and *A. chirurgus* (doctorfish). Along with parrotfish (*Scaridae*) and damselfish (*Pomicentridae*), these animals are primarily herbivores, and together they form the largest portion of fish biomass of reef systems (Thresher 1980). Such fishes feed on many species of small benthic algae, which are generally poorly digested, although consistent differences in food quality may occur among major taxa or growth forms of algae (Montgomery and Gerking 1980). There has been documentation of selective feeding in schooling surgeonfish responding to these differences, but nonselective feeding behavior is probably more common in wandering species (Randall 1967, Montgomery 1980, Montgomery et al. 1989, Roberts 1987).

Tangs are browsers, with lips and dentition for snipping off the tips and branches of algae. However, anatomical differences between species, particularly with the digestive tract is evident, leading one to suspect varying dietary preferences between these species. The blue tang, *A. coeruleus*, has a long thin-walled digestive tract, while the doctorfish, *A. chirurgus*, and ocean surgeonfish, *A. bahianus*, have sand-filled, muscular gizzard-like stomachs (Tilghman et al. 2001). Herbivorous fish are not known to produce cellulase or other enzymes to digest cell wall components (Lobel 1981). However, they are capable of digesting the materials inside plant cells if they have developed mechanisms to break the cell walls. This can be done in two ways. One method is Trituration, which occurs through chewing, or the material is be masticated in a muscular, gizzard-like stomach. An alternative strategy is the use of acidic stomach secretions, typically secreted by thin-walled stomachs (Lobel 1981). Acanthurids found in the Florida Keys possess both stomach types (Tilghman et al. 2001), so it is likely that they utilize both mechanisms to break algal cell walls.

This histological atlas focuses on *A. coeruleus* and includes major organs and tissues. Particularly note the stomach tissues of both species, which illustrate the difference in digestive strategies of the Carribbean Acanthurids. *Acanthurus chirurgus* was intentionally left out of this atlas, as its tissues are identical to those of ?*A. bahianus.*

The surgeonfish used for this atlas were obtained from the Florida Keys between 1999 - 2000. They ranged in size from 68 - 318 mm total length. Tissues were collected immediately after euthanasia with methane tricaine sulfonate (MS-222) and fixed with commercially available 10% buffered formalin (Fisher Scientific, Atlanta, GA). Calcified structures found in skin and gill tissues were decalcified with Cal-Ex® (Fisher Scientific, Atlanta, GA) prior to histological processing. The tissues were then embedded in paraffin, cut into five micron sections and stained with 7211 hematoxylin and eosin with phloxine (Richard Allen Scientific Co., Kalamazoo, MI). Photographs were taken with an Olympus DP-11 digital camera (Olympus Optics).

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Blue Tang

Acanthurus coeruleus

Size: 125-275 mm
ID: This acanthurid is distinguished by its bright blue coloration. For this reason, it is the most sought after Atlantic surgeonfish for the aquarium trade.

Class: Actinopterygii / Ray-finned fishes
Order: Perciformes / Perch-like fishes
Family: Acanthuridae / Surgeonfishes
Genus Species: Acanthurus coeruleus / Blue Tang
Habitat: Reef. The blue tang is found from New York to São Paolo (Roca et al., 2002), and throughout the Caribbean and Gulf of Mexico.
Food: Primarily herbivorous; feed on brown and red benthic algae. (Tilghman et al., 2001)

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Ocean Surgeon

Acanthurus bahianus

Size: 125-275 mm
ID: These fish are distinguished from their coexisting acanthurids by their gray coloration, white caudal peduncle, and a highly lunate caudal fin.
Class: Actinopterygii / Ray-finned fishes

Order: Perciformes / Perch-like fishes
Family: Acanthuridae / Surgeonfishes
Genus Species: Acanthurus bahianus / Ocean Surgeonfish
Habitat: Reef. The ocean surgeonfish Acanthurus bahianus is found throughout the tropical western Atlantic from North America to southern Brazil (Roca et al., 2002). It also occurs in the oceanic islands of Bermuda and in the southern Atlantic islands of Fernando de Noronha, Atol das Rocas, Trindade, Ascension and St. Helena (Randall 1957, Floeter et al., 2001).
Food: Primarily herbivorous; feed on green and brown algae as well as small invertebrates. This species also ingests large amounts of sand, presumably to aid in the digestion of algae. (Tilghman et al., 2001)

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Doctorfish

Acanthurus chirurgus

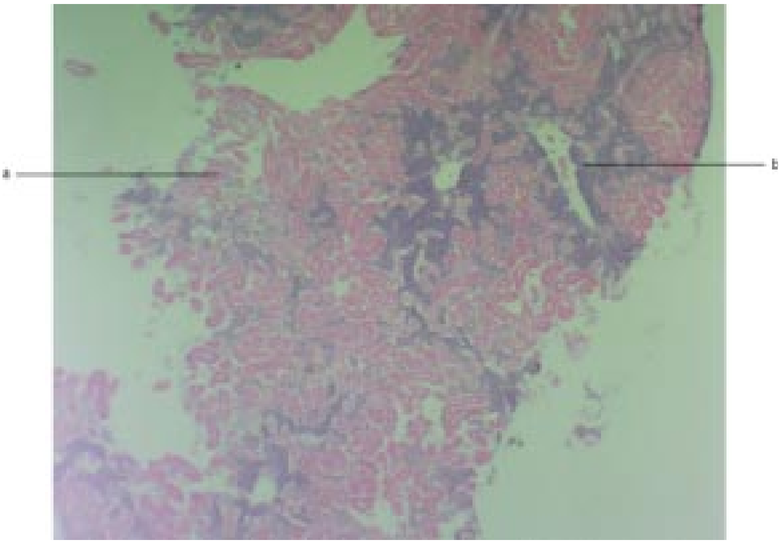
Size: 125-275 mm
ID: Distictive vertical bars, white caudle peduncle
Class: Actinopterygii / Ray-finned fishes
Order: Perciformes / Perch-like fishes

Family: Acanthuridae / Surgeonfishes
Genus Species: Acanthurus chirurgus / Doctorfish
Habitat: Reef
Food: Primarily herbivorous; feed on green and brown algae as well as small invertibrates. This species also ingests large amounts of sand, presumably to aid in the digestion of algae. (Tilghman et al., 2001)

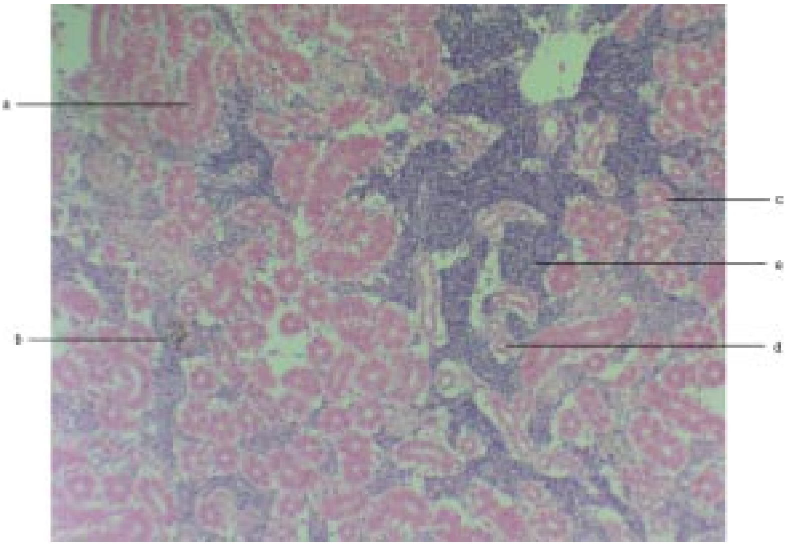
Blue Tang

Acanthurus coeruleus

Kidney



Kidney (100x). a) tubule. b) interrenal tissue. c) glomerulus.



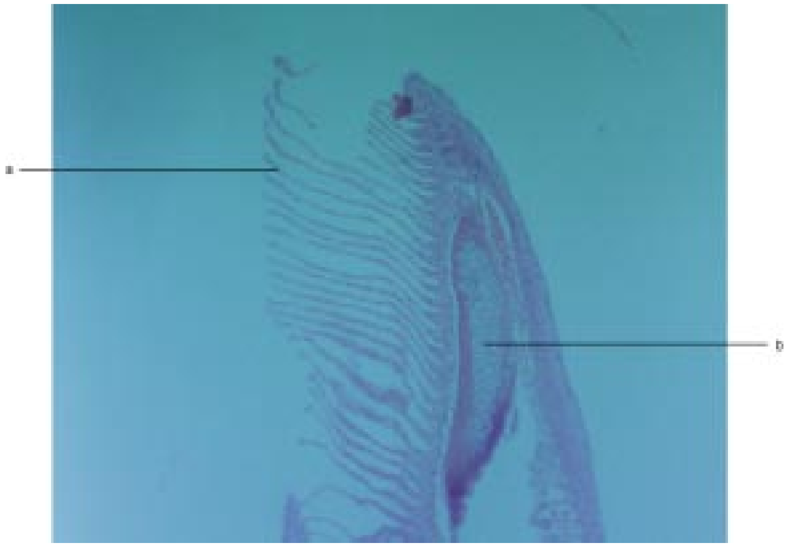
Kidney (250x). a) proximal tubule segment. b) melanomacrophage center. c) collecting tubule. d) distal tubule segment. e) interrenal tissue. The apparent fewer number of melanomacrophage centers is not specific to this species and can be attributed to a number of factors.

The kidney is not divided into grossly distinct anterior and posterior sections as it is in many fish species. Function is evident at the microscopic level.

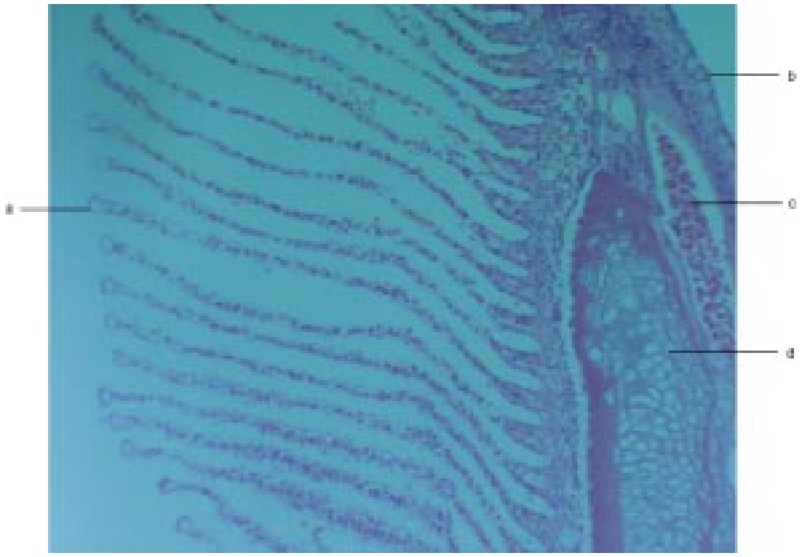
Most teleosts have anterior and posterior kidneys, with the anterior involved in excretory function and posterior acting in the hematopoetic role. In hematoxylin and eosin stained specimens, basophilic interrenal tissue is hematopoetic.

Blue Tang
Acanthurus coeruleus

Gills



Gill (100x). a) secondary lamella. b) cartilage of primary lamella

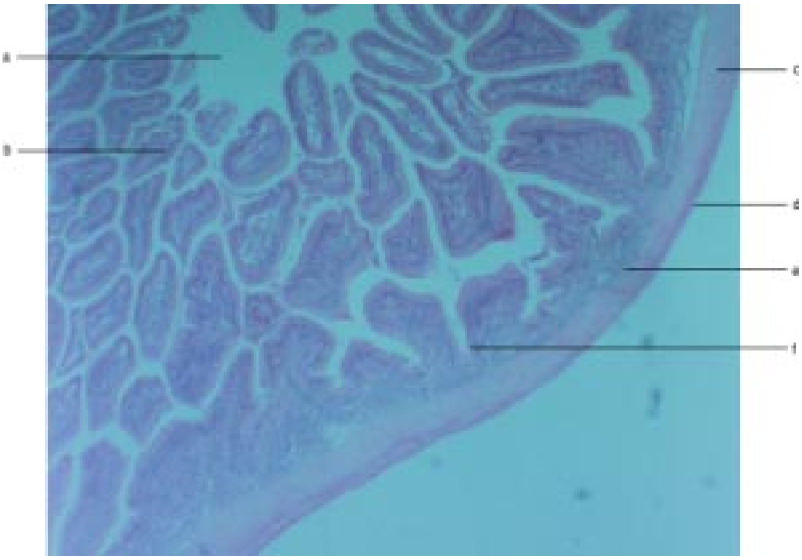


Gill (250x). a) epithelium. b) mucus cell. c) central venous sinus. d) cartilage.

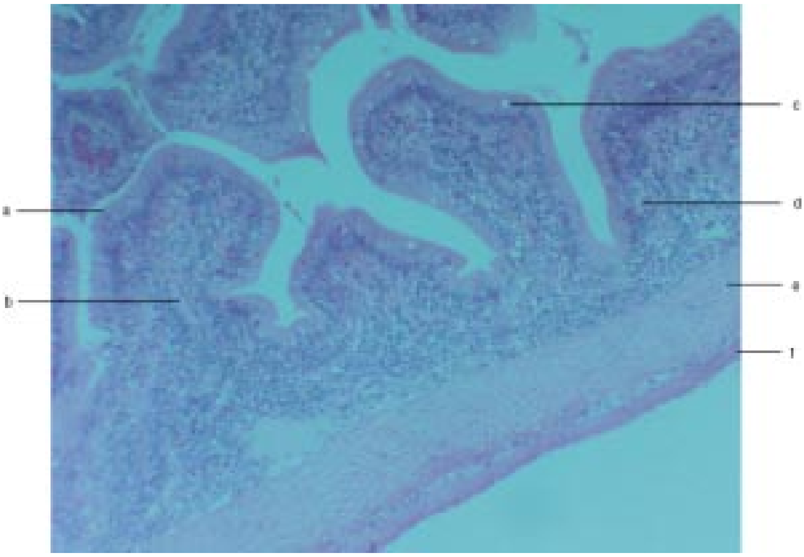
Blue Tang

Acanthurus coeruleus

Intestine



Anterior section of intestine (100x). a) lumen. b) goblet cell. c) circular muscle layer. d) longitudinal muscle layer. e) submucosa. f) mucosa.

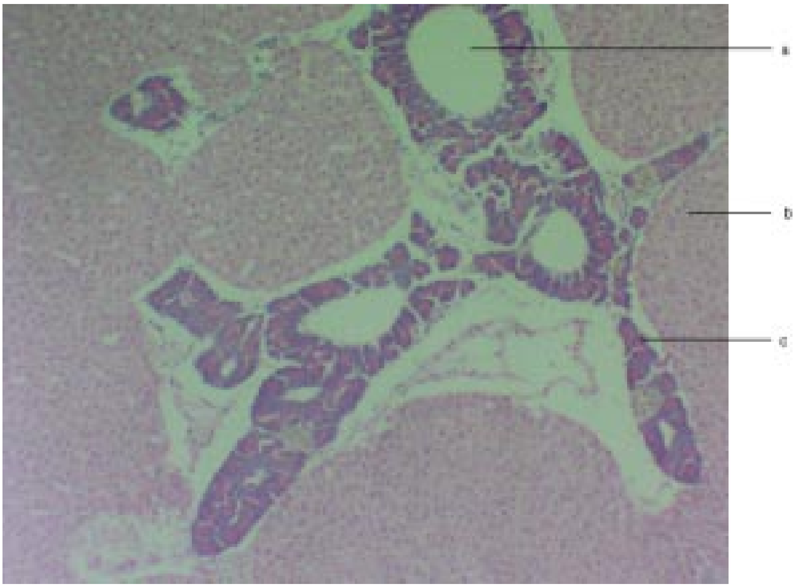


Intestine (250x). a) lamina epitheliasis. b) submucosa. c) goblet cell. d) mucosa. e) muscularis circularis. f) muscularis longitudinalis.

Blue Tang

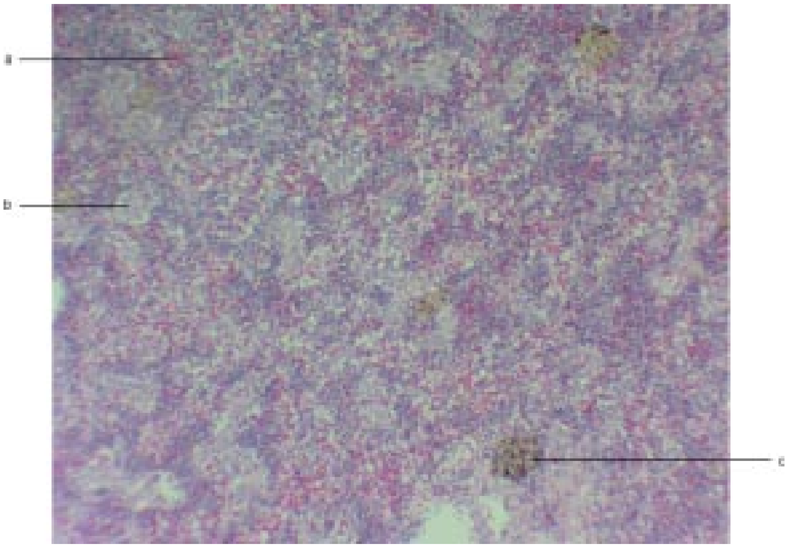
Acanthurus coeruleus

Hepatopancreas



Hepatopancreas (250x). (a) hepatic duct. Note the basophillic pancreatic tissue surrounding the ducts. (b) hepatic tissue. (c) pancreatic tissue.

Spleen

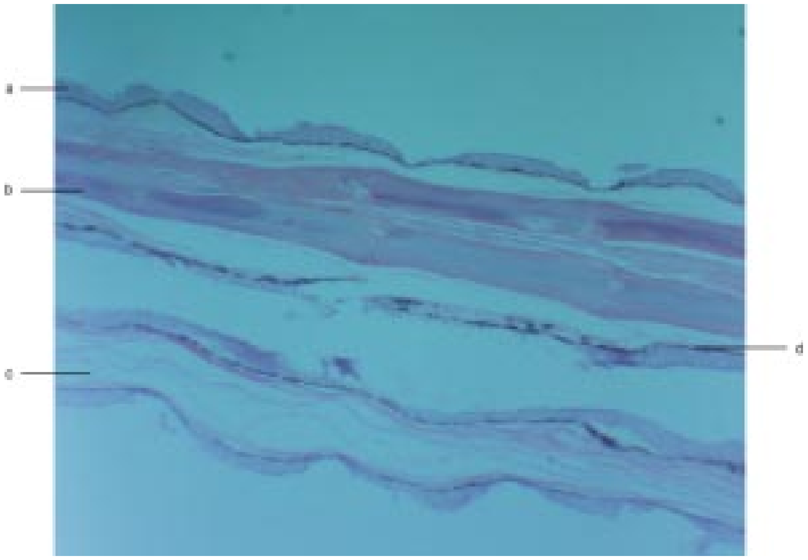


Spleen (250x). a) red pulp. b) white pulp. c) melanomacrophage center.

Blue Tang

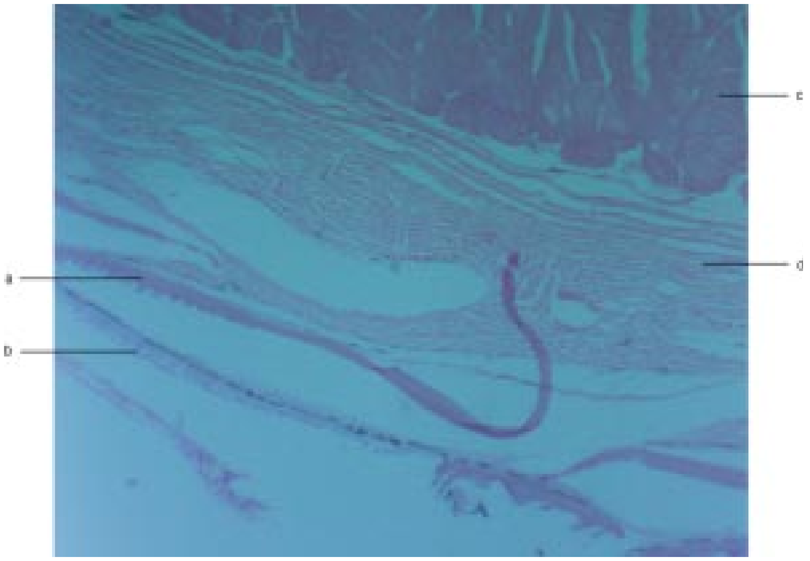
Acanthurus coeruleus

Fin



Fin (100x). a) epidermis. b) bone. c) stratum spongiosum. d) melanin layer

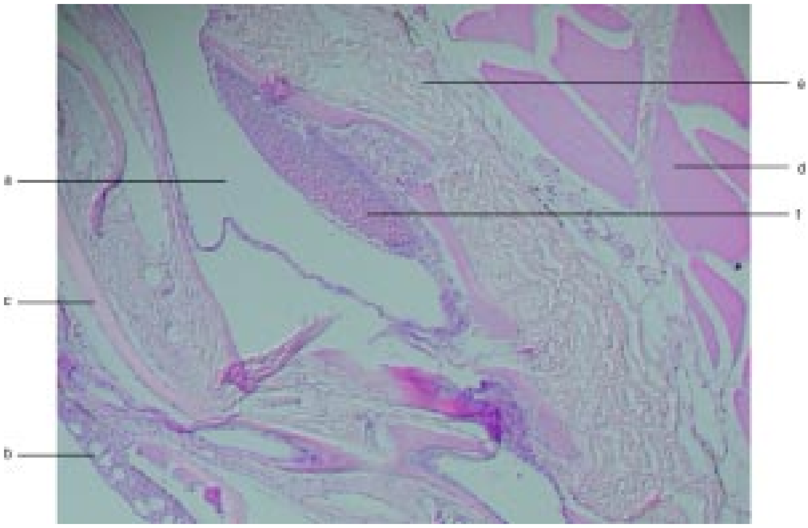
Skin



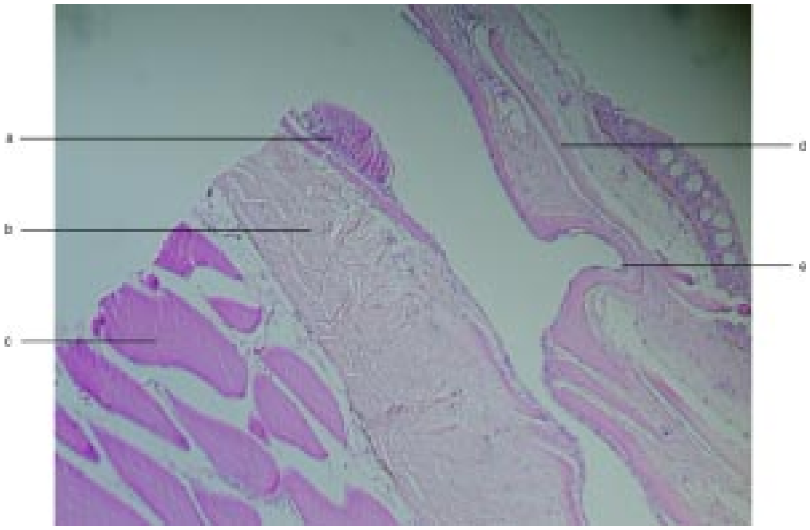
Skin (100x). a) scale. b) epithelium. c) muscularis. d) dermis.

Blue Tang
Acanthurus coeruleus

Skin



Lateral section of skin with lateral line canal (250x). a) canal lumen. b) goblet cell. c) scale. d) muscle. e) loose connective tissue. f) sensory epithelium. The lateral line system of acanthurids is often the sight of extensive erosion in captive fish. Much speculation as to the etiology of these lesions has been discussed, but some anecdotal information as well as a few studies suggest that nutrition may be involved.

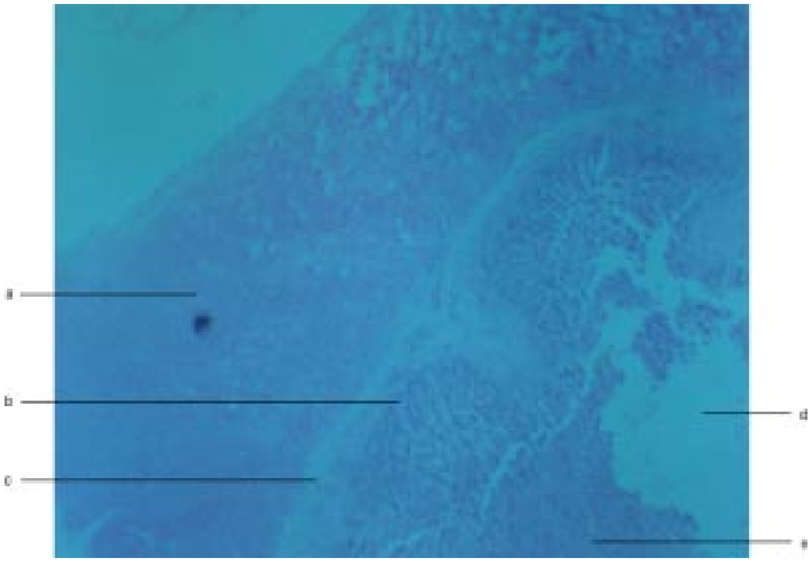


Lateral section of skin with lateral line canal (250x). a) sensory epithelium. b) loose connective tissue. c) muscle. d) scale. e) canal pore.

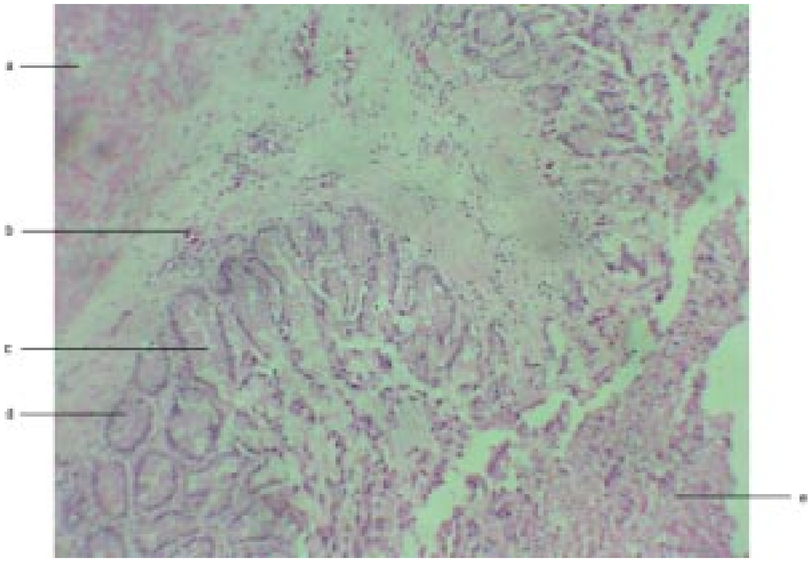
Blue Tang

Acanthurus coeruleus

Stomach



Stomach (100x). Note the relatively low muscularis-to-mucosa size ratio in this species. a)muscularis. b) gastric gland. c) submucosa. d) lumen. e) mucosa. This species undoubtedly utilizes acidic stomach secretions to break the cell walls of their algal forage, as do other acanthurids that have similar stomach morphology (Lobel). In contrast to A. bahianus, wild-caught A. coeruleus stomachs are found full of algae, with little or no sand. Grossly, they are very thin-walled with relatively large luminal volumes.

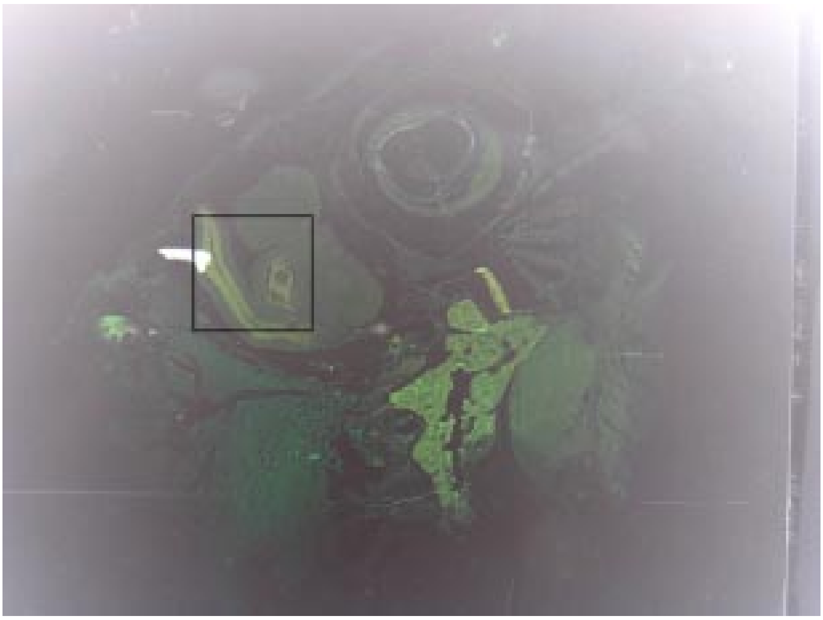


Stomach (250x). a) muscularis. b) submucosa. c) gastric gland. d) goblet cell. e) mucosa.

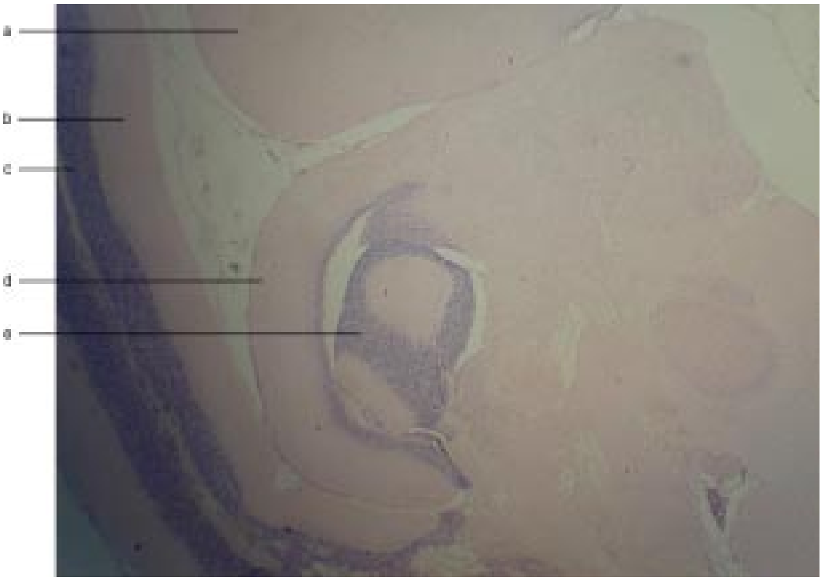
Blue Tang

Acanthurus coeruleus

Brain



Sagittal section of the head (6.3x). Notice the orientation of the brain anterior to the eye, which appears rotated anteriorly compared to other teleosts' brains. Area of inset is magnified in figure 15. (Negative image used to increase contrast.)

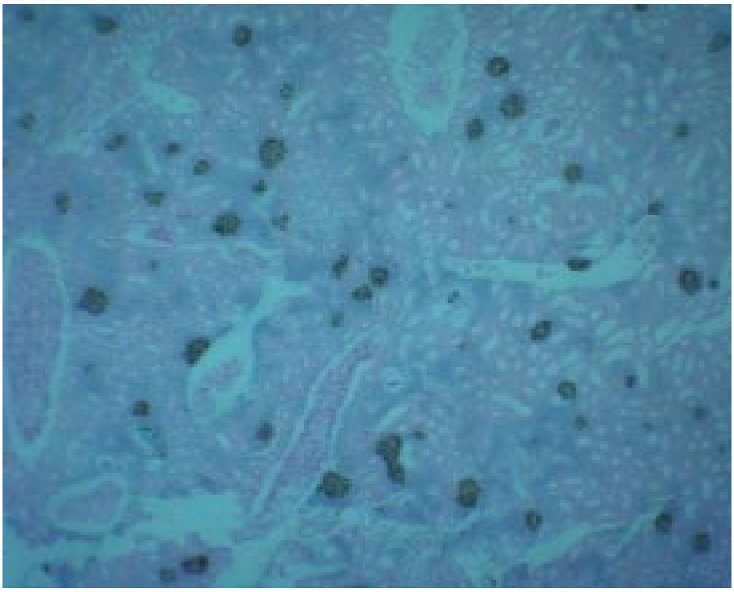


Sagittal section of the brain (40x). a) cerebellum. b) olfactory bulb. c) nasal epithelium. d) optic tectum. e) torus semicurcularis.

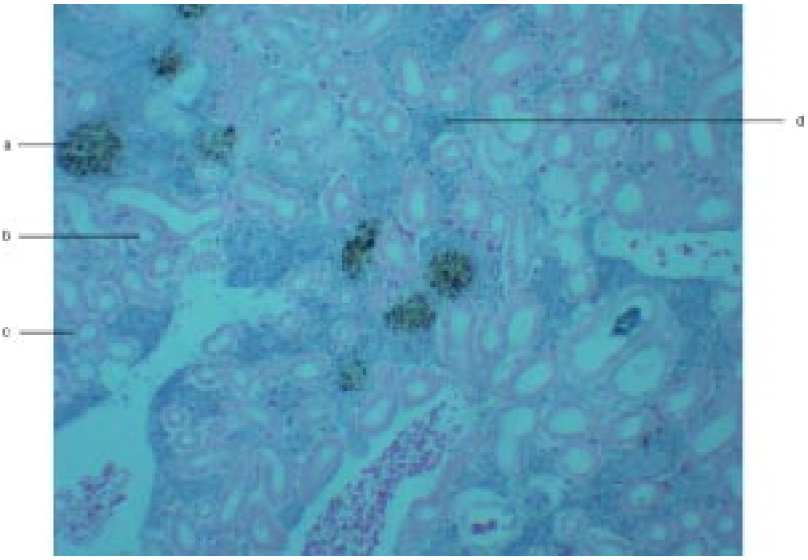
Ocean Surgeon

Acanthurus bahianus

Kidney



Kidney (100x)



Kidney (250x). a) melanomacrophage center. b) proximal tubule. c) distal tubule. d) hematopoetic tissue.

The apparent fewer number of melanomacrophage centers is not specific to this species and can be attributed to a number of factors. The kidney is not divided into grossly distinct anterior and posterior sections as it is in many fish species. Function is evident at the microscopic level.

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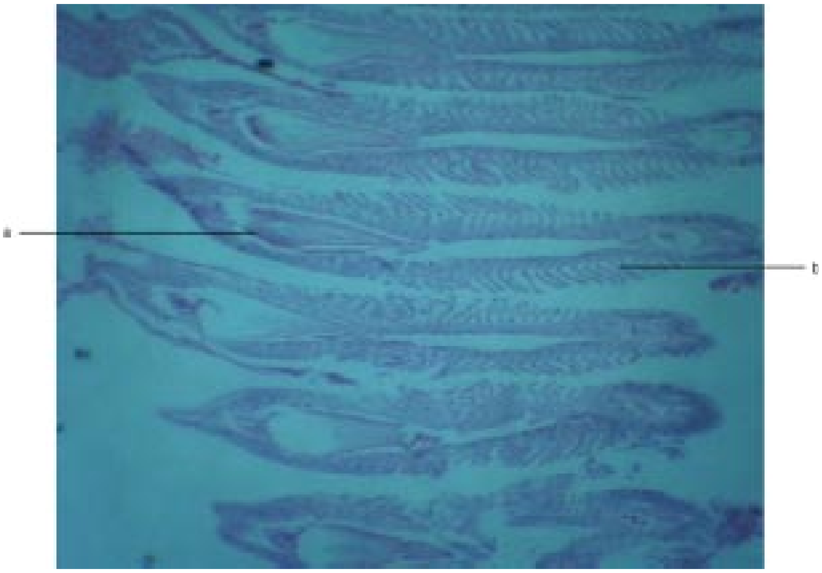
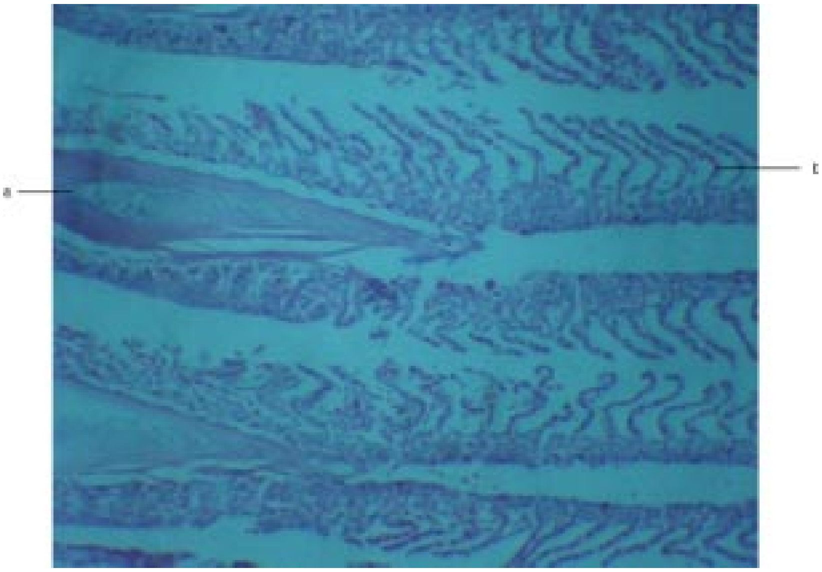
Ocean Surgeon

Acanthurus bahianus

Gills



Gills (100x). a) primary lamella. b) secondary lamellae.

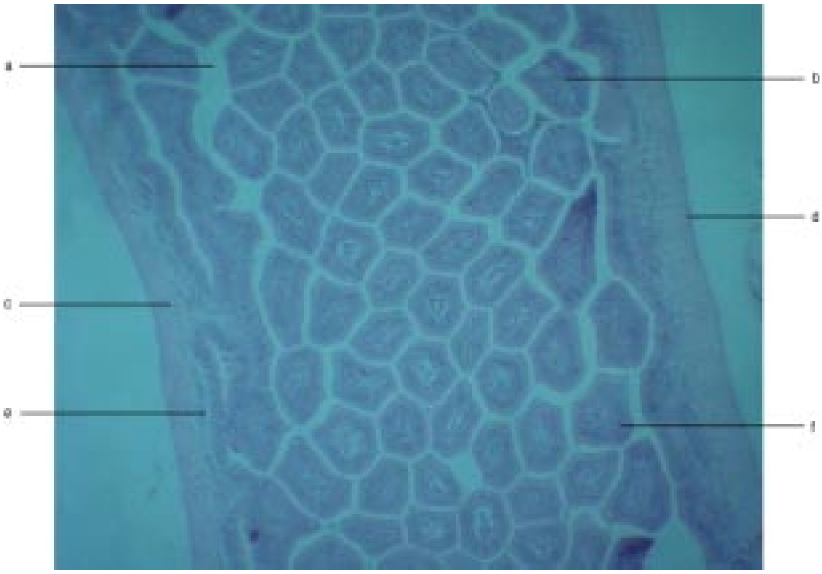


Gills (250x). a) primary lamella cartilage. b) secondary lamella. The gills' function as an environmental interface make it one of the first sights of pathology development. Hyperplastic or hemorrhagic secondary lamellae are often indicative of environmental or pathogenic problems.

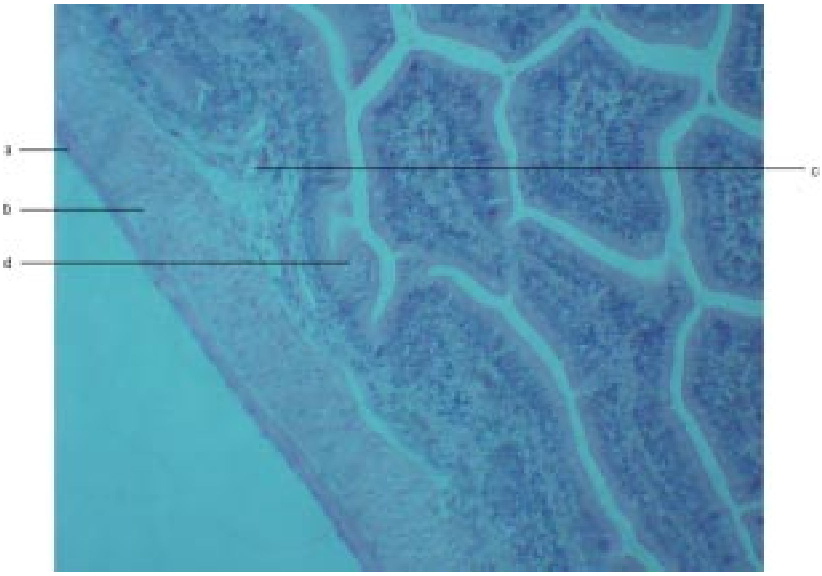
Ocean Surgeon

Acanthurus bahianus

Intestine



Anterior section of intestine (100x). a) lumen. b) goblet cell. c) circular muscle layer. d) longitudinal muscle layer. e) submucosa. f) mucosa.

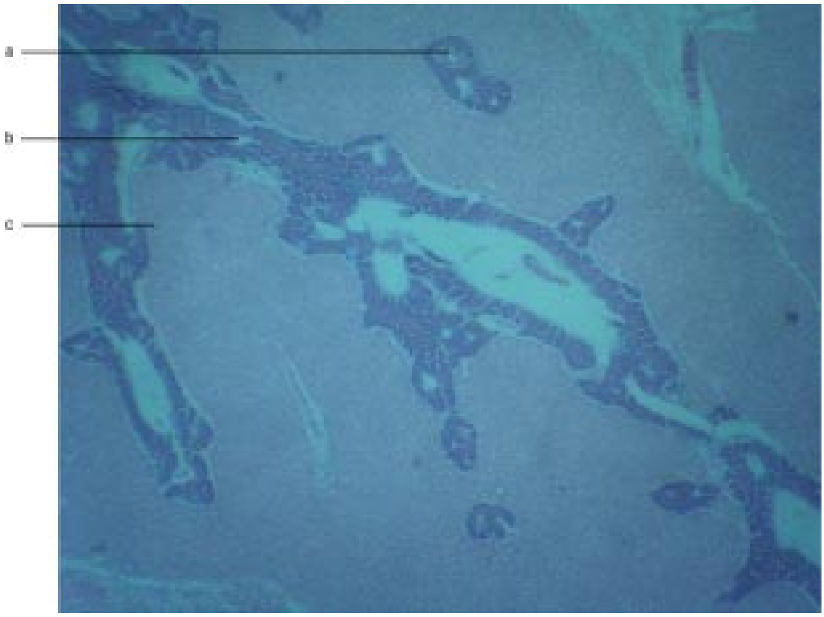


Logitudinal section of the anterior intestine (250x). a) muscularis longitudinalis. b) muscularis circularis. c) lamina propria. d) lamina epitheliasis. The gut length to total length ratio in these fish is about 2 : 1, and is suggestive of their primarily herbivorous diet. The thin-walled, tightly coiled intestines of these fish are filled with sand (in wild-caught fish) and are often teeming with various flora and fauna that may aid in the digestion of their algal forage.

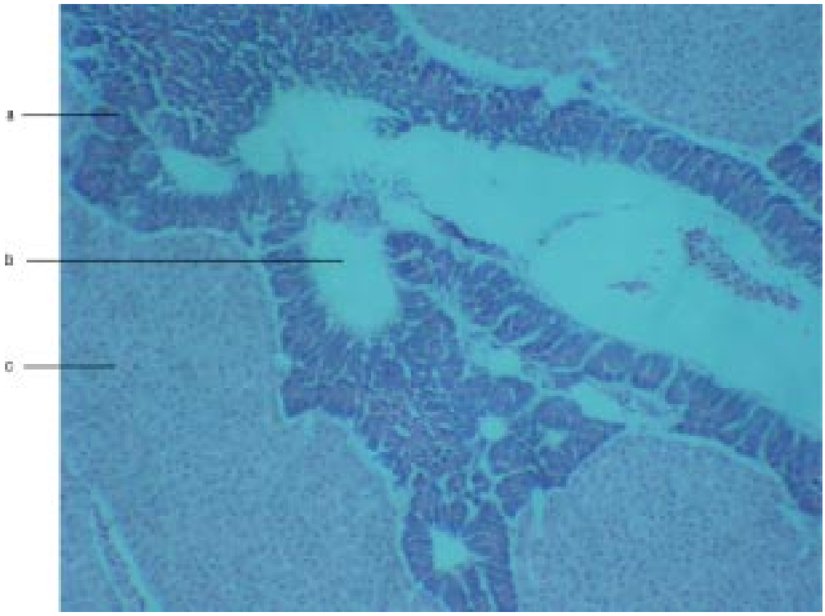
Ocean Surgeon

Acanthurus bahianus

Hepatopancreas



Hepatopancreas (100x). a) bile duct. Note basophillic pancreatic tissue (b), surrounding the hepatic ducts. Hepatic tissue (c) is eosinophillic.

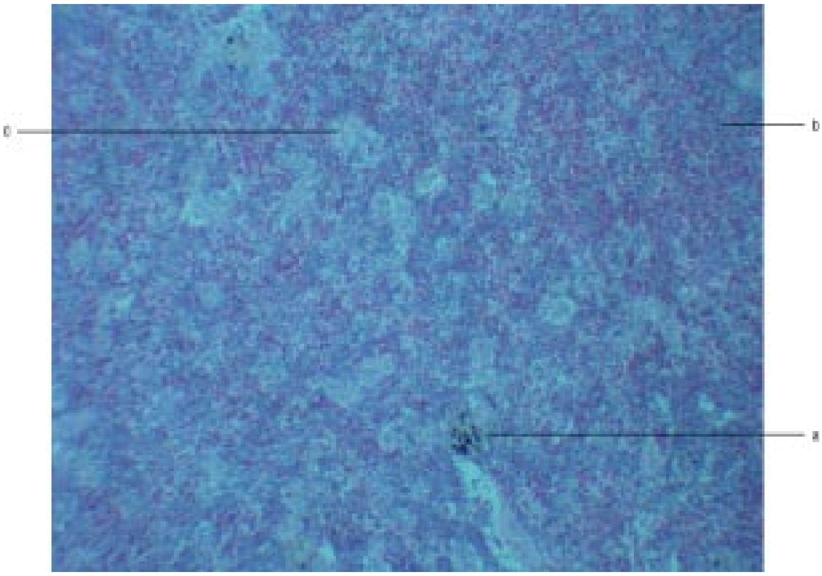


Hepatopancreas (250x). a) pancreatic tissue. b) hepatic portal vein. c) hepatic tissue. The hepatic tissue is often interspersed with melanomacrophage centers, which are amber-colored areas. Smaller than normal hepatocytes may be indicative of starvation or other problems. Excess fat deposition in the hepatopancreas can reduce liver function, and is often seen in improperly fed aquarium specimens. A liver sample that floats in formalin is abnormally high in fat content.

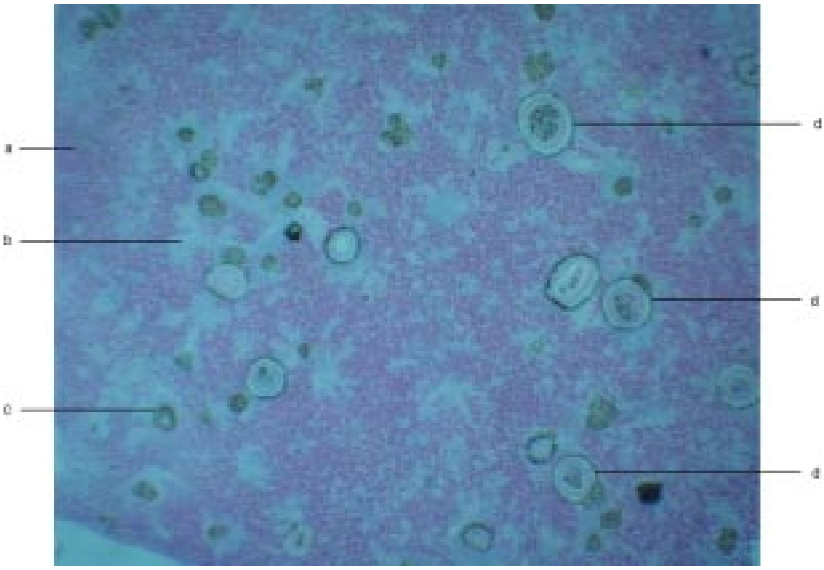
Ocean Surgeon

Acanthurus bahianus

Spleen



Spleen (250x).). a) melanomacrophage center. b) red pulp. c) white pulp. As in the liver, splenic tissue is often interspersed with melanomacrophage centers. This organ's function as a hematopoietic center and blood filter make it a good place to look for pathogens. Gross granulomatous lesions may sometimes be seen after chronic exposure to bacterial or parasitic agents.

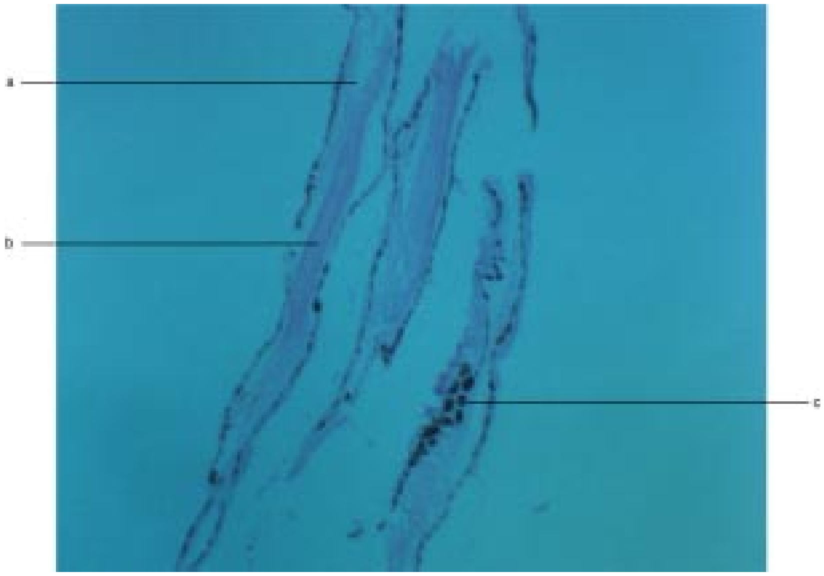


Spleen with heavy nematode infestation (100x). a) red pulp. b) white pulp. c) melanomacrophage center. d) nematode (cross section).

Ocean Surgeon

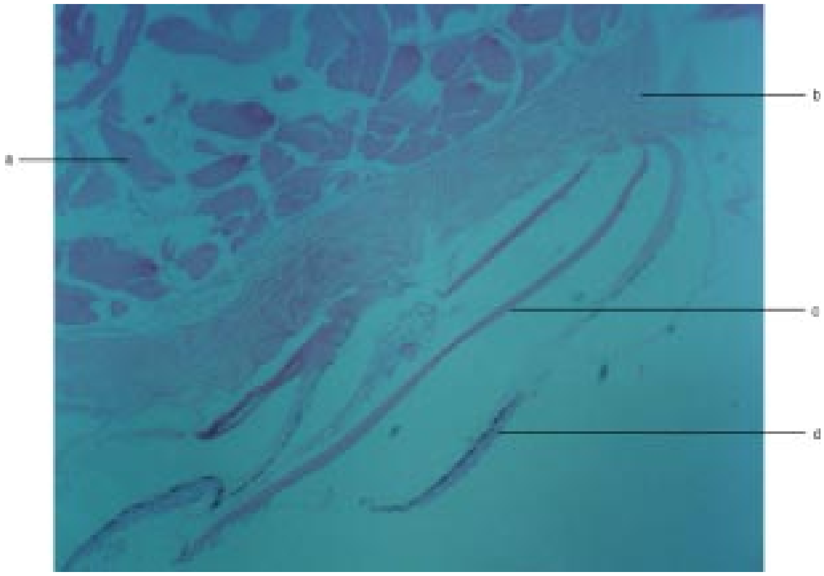
Acanthurus bahianus

Fin



Fin (100x). a) epithelium. b) cartilage. c) melanophores. Fins are a common site of parasitism. Most of these can be seen grossly, however, and histological exam is often unnecessary. In acanthurids, monogenes and turbellarians are most often seen here. Fin spines in acanthurids with advanced head and lateral line erosion syndrome are often thickened and deformed.

Skin

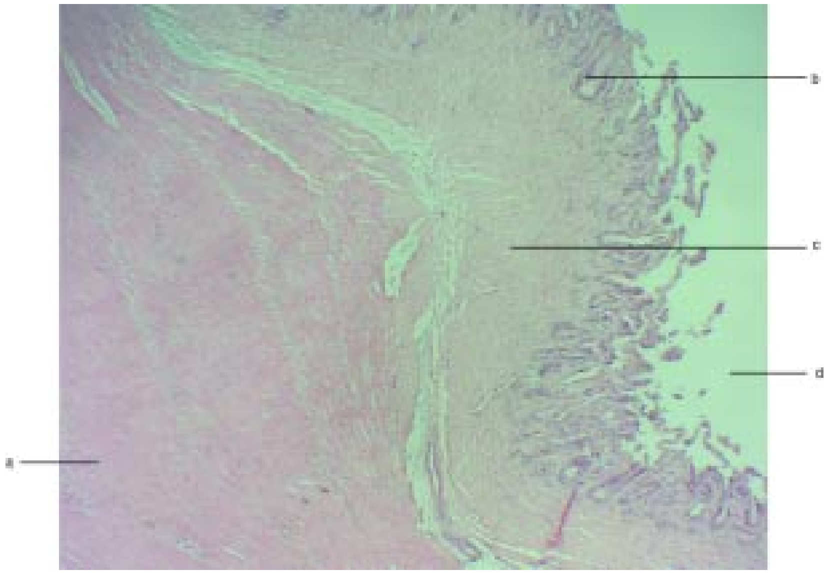


Skin (100x). a) muscle. b) dermis. c) scale (ctenoid type). d) epidermis. The skin is often the sight of pathology in fishes, since its role is a barrier to the environment and the pathogenic challenges therein. Most often, skin pathology can be determined by microscopic study of scrapings, however internal or systemic conditions that lead to skin pathology may only be observed in histological sections.

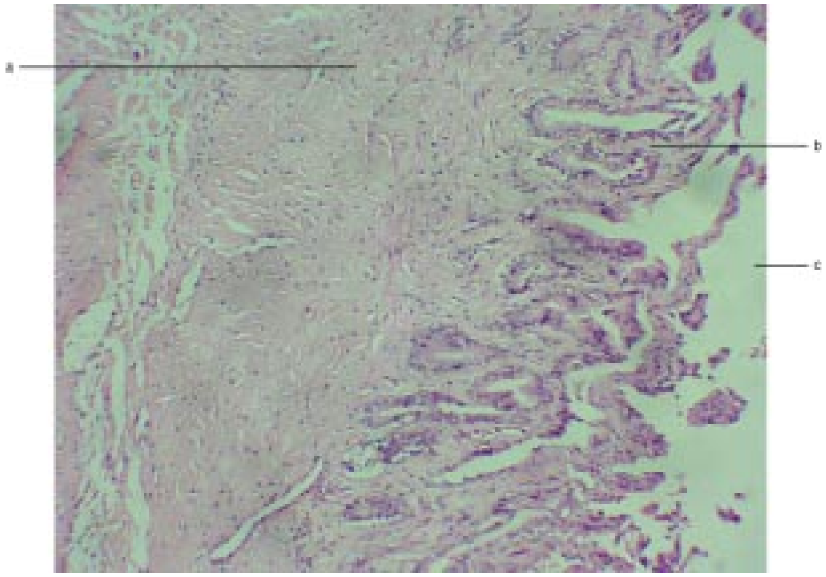
Ocean Surgeon

Acanthurus bahianus

Stomach



Stomach (250x). The actual size of the muscularis (a) is ~ 4x that of the submucosa (c) in this species, and is even more pronounced in larger specimens. b) gastric gland. d) lumen.

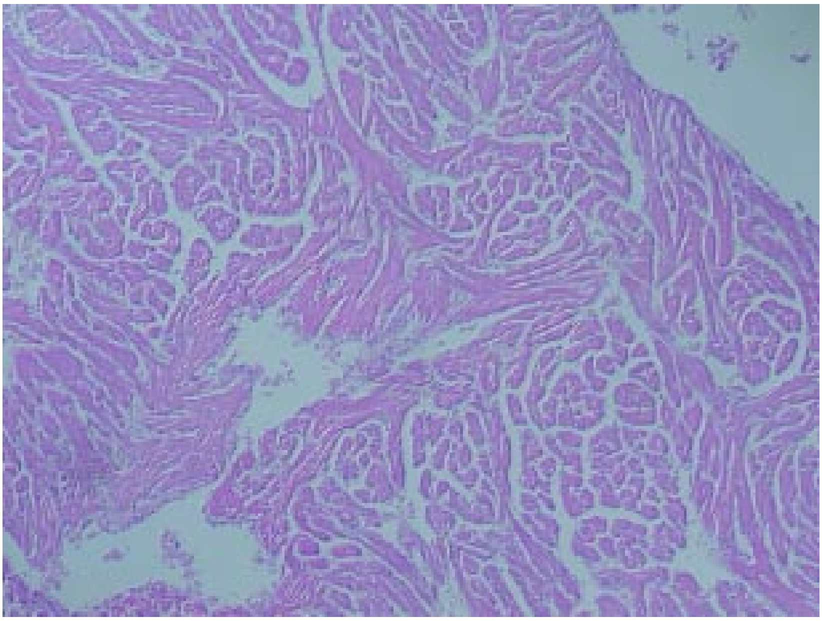


Stomach (250x). a) submucosa. b) gastric gland. c) lumen.

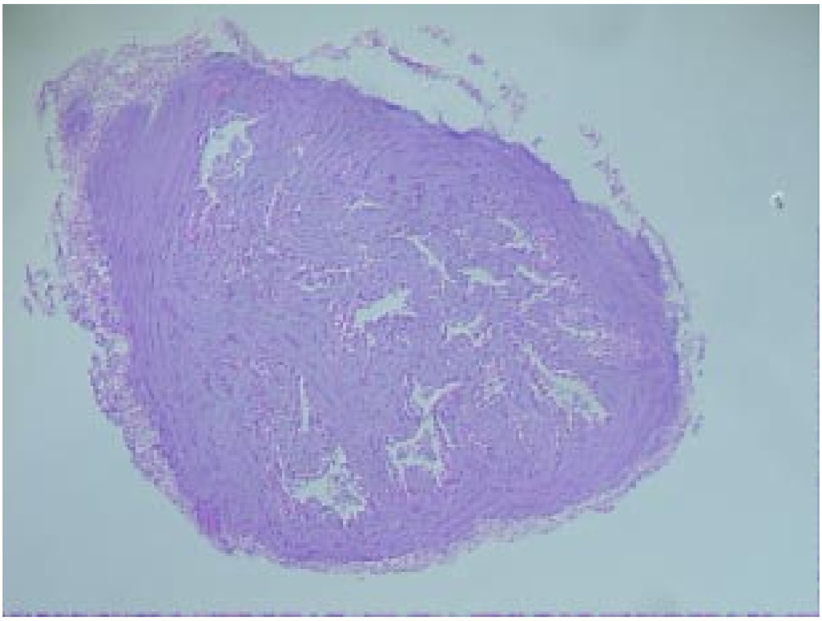
Ocean Surgeon

Acanthurus bahianus

Heart



Ventricle (250x)



Bulbus arteriosus (250x)

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